

THERMOTRON

MINI-MAX/MODEL SM-16C

TEMPERATURE/HUMIDITY TEST CHAMBER

MINIMUM PRICE
MAXIMUM PERFORMANCE

STANDARD FEATURES:

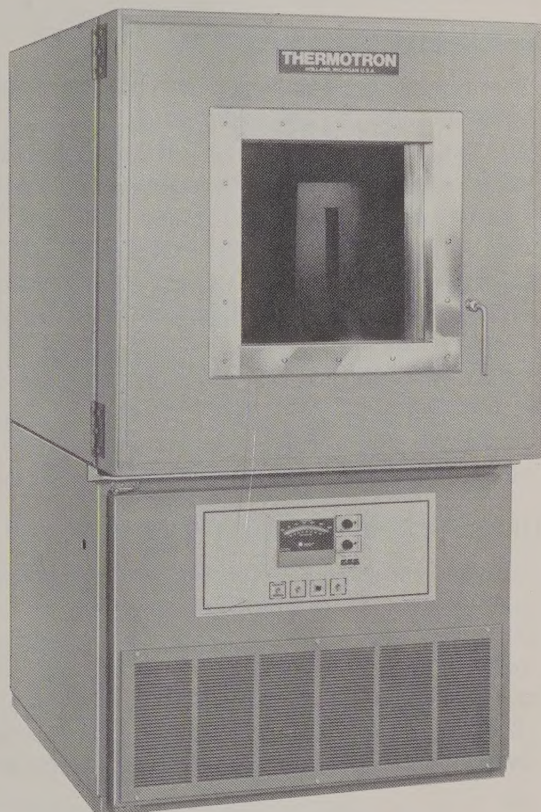
- 20" x 20" heat tempered multipane window
- Interior light.
- 4" Stainless Steel Port and Plug
- Manual Window Wiper
- Stainless Steel Drip Pan
- Thermotron Solid State Temperature controllers (Dry Bulb and Wet Bulb)
- High Volume Air Circulation Fan
- 16 cubic feet of work space (439 liters)
- Thermotron one-year limited Warranty

CABINET:

1. Exterior dimensions (overall) 45½" wide (116 cm) x 57¾" deep (147 cm) x 78" high (198 cm).
2. Interior dimensions (clear usable work space) 30" wide (76 cm) x 30" deep (76 cm) x 30" high (76 cm).
3. 304 Series, High Nickel content, stainless Steel Liner. Liner is Heli-arc welded for vapor-tight seal.
4. Extruded, Seamless Corner, Silicone Gaskets, designed for the application. Dual Gaskets assure vapor tight seal and minimum Heat Loss.
5. Galvanized Steel Exterior Finished in Thermotron Blue Lacquer.
6. Hinged Front Panel for easy service and calibration.
7. External Circulator Motor with Stainless Steel Shaft.
8. Shipping Weight is Apx. 1195 Pounds.

ELECTRICAL SYSTEM:

1. Chamber has solid state Photo-isolated zero voltage switching, heating relays.
2. All Wires are identified.
3. Chamber Over-temperature protection, Fusible heat link.
4. All components are fused.
5. Master Heat and Humidity Heat Contractors Provided.
6. Wiring meets NEC and NEMA Standards.



INSTRUMENTATION:

1. Dry Bulb and Wet Bulb Controllers are operated by Thermocouple Sensors.
2. The Thermotron Humidity Instrumentation Control System Combines a precision Mirrored Back Panel Meter (Dual Calibration in °C. and °F.) and two multi-turn Set Point Potentiometers to indicate Dry Bulb and Wet Bulb Thermocouple Signals and Dry Bulb and Wet Bulb Set Point Signals on a Single Analog Scale. This unique System eliminates Set Point-Temperature Indicator Calibration errors by using a Common Meter to indicate both Functions. Indicating accuracy $\pm 1\%$ of span. Upscale, open T/C Protection.
3. Controllers Simulate Proportioning and Reset action.
4. Range:
Standard -87.24°C (-125°F) to $+190.56^{\circ}\text{C}$ ($+375^{\circ}\text{F}$)

AVAILABLE VOLTAGES:

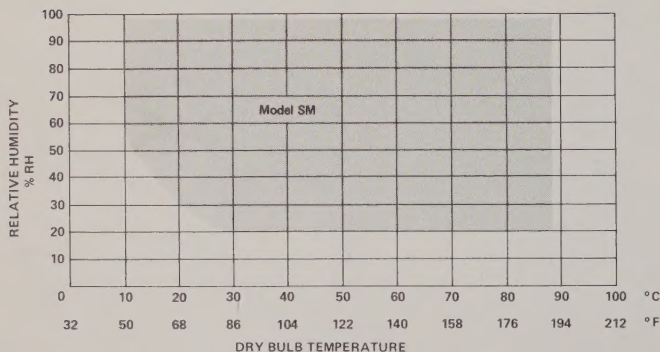
1. 230 Volt, 1 Ph., 60 Hz. $\pm 10\%$ Recommended Service, 60 Amp Time Delay Fuses.
2. 230 Volt, 3 Ph., 60 Hz. $\pm 10\%$ Semibalanced load available by reconnecting Power input Connectors. Recommended Service 40 Amp time delay Fuses.
3. 200 Volt, 1 Ph., 50 Hz., with 83% capacity. Recommended Service 60 Amp time Delay Fuses.

REFRIGERATION SYSTEM:

1. Thermotron Cascade System with all silfos or silver soldered joints (no soft solder used).
2. Air Cooled Refrigeration System capable of starting under various Ambient conditions.
3. Heavy-Duty Copper Tube Cooling Coils with aluminum fins. Designed for the Application.
4. Refrigeration System uses Standard Refrigerant 13 and Refrigerant 502. Easily available at refrigeration supply houses.
5. Liquid injection circuit to cool compressors and insure long compressor life.
6. Cascade condensers are manufactured by Thermotron Corporation to our own High Standards.

HUMIDITY/DEHUMIDITY SYSTEM:

1. Humidity Provided by Thermotron designed and manufactured Vapor Pressure Generator.
2. Balanced, non cycling—Continuous operation of the Refrigeration Compressor Assures Long Component Life and Precision Humidity Control.
3. Humidity System Switch Disables total Humidity System when Temperature cycling only is required.



PERFORMANCE:

Temperature Range:

$-68^{\circ}\text{C. } (-90^{\circ}\text{F.})$ to $+93^{\circ}\text{C. } (+200^{\circ}\text{F.})$

Temperature	to -40°F. in 20 min.
Pulldown From	to -65°F. in 30 min.
$+75^{\circ}\text{F.}$ Ambient	to -85°F. in 40 min.
without load	to -90°F. in 60 min.

Temperature	-90°F. to $+75^{\circ}\text{F.}$ in 25 min.
Heatup	$+75^{\circ}\text{F.}$ to $+200^{\circ}\text{F.}$ in 20 min.
without load	optional ($+75^{\circ}\text{F.}$ to $+350^{\circ}\text{F.}$ in 55 min.)

Capacity for	
Holding Live Loads	at 0°F. 1000 watts
At temperatures	at -40°F. 700 watts
Below $+100^{\circ}\text{F.}$ only	at -65°F. 400 watts

Humidity Range:

20% to 98% in the dry bulb range of $+35^{\circ}\text{F.}$ to $+190^{\circ}\text{F.}$ as limited by $+35^{\circ}\text{F.}$ dew point.

(See chart #HE-1 for typical performance.)

Capacity for	
Holding Live Loads	at 95% RH 400 watts
With Humidity	at 50% RH 750 watts

Control: Air Temperature Control as measured at the Control Thermocouples.

$\pm \frac{1}{2}^{\circ}\text{F.}$ Dry Bulb and Wet Bulb.

$\pm 2\frac{1}{2}\%$ RH with standard instrument range.

Performance is based on 60Hz operation and $+80^{\circ}\text{F. } (+27^{\circ}\text{C.})$ Ambient Air for 50 Hz operation. Stated performance and Air Flow will be Apx. 17% less (.8333).

The Addition of Accessories may Reduce Performance.
Accessories list available upon request.

Dallas Area Office
Keystone South
Suite 2319
Dallas, Texas 75243
Phone: (214) 231-3663

Los Angeles Area Office
8934 Mason Avenue
Chatsworth, California 91311
Phone: (213) 882-5030

New York Area Office
1850 Lansdowne Avenue
Merrick, New York 11566
Phone: (516) 868-1800

San Francisco Area Office
50 Curtner Avenue
Campbell, California 95008
Phone: (408) 371-5961

OFFICES IN PRINCIPAL CITIES

THERMOTRON CORP.

KOLLEN PARK DR., HOLLAND, MICH. 49423 PH (616) 392-1492



Carlsbad Area Office
800 Grand Avenue
Suite C-9
Carlsbad, California 92008
Phone: (714) 729-7126

Florida Area Office
P. O. Box 16051
Orlando, Florida 32861
Phone: (305) 843-8935

THE THERMOTRON INSTRUCTION MANUAL

Thermotron instruction manuals are dedicated to assisting the reader-user toward a better understanding of Thermotron Environmental Chambers and associated equipment. Most instruction manuals are seldom read except in the time of crisis when equipment malfunction is suspected. When this happens, the manual is usually missing, or at best, difficult to locate. So to start things off on the right foot, WHY NOT FIND A CONVENIENT SPOT TO KEEP THIS MANUAL?

We at Thermotron have tried to produce a usable manual. But being human, we are subject to frailties of behavior. Therefore, should you discover any errors or omissions, or should you wish to contribute any recommendations, send us your comments. We at Thermotron will be most appreciative.

WARNINGPRODUCT PROTECTION

When operating this chamber with a live load (heat dissipating product) or a dead load, auxiliary protection should be provided by the operator (customer). Provision must be made to remove power from the product on test and the chamber in the event the chamber temperature exceeds a predetermined safe limit for the product within the chamber.

Thermotron chambers are equipped with high heat limit, or safety devices. These safety devices are installed to protect the chamber from exceeding design limits. These safety devices remove power ONLY from the chamber heaters and DO NOT remove power from your product; therefore, a device such as the THERMOTRON PRODUCTSaver, or equivalent, must be used to remove power from the product and the chamber should an "out of tolerance" condition occur.

The PRODUCTSaver is designed with concealed setpoints for high and low temperatures. These can be precisely set at a temperature limit to permit safe operations. Power to the product and a circuit interrupting power to the chamber must both be wired through the output relays of the PRODUCTSaver. The PRODUCTSaver will then shut down chamber operation and product operation within the safe operating temperature limits of the product, either hot or cold.

THERMOTRON

AUTOMATIC CONTROL SYSTEMS

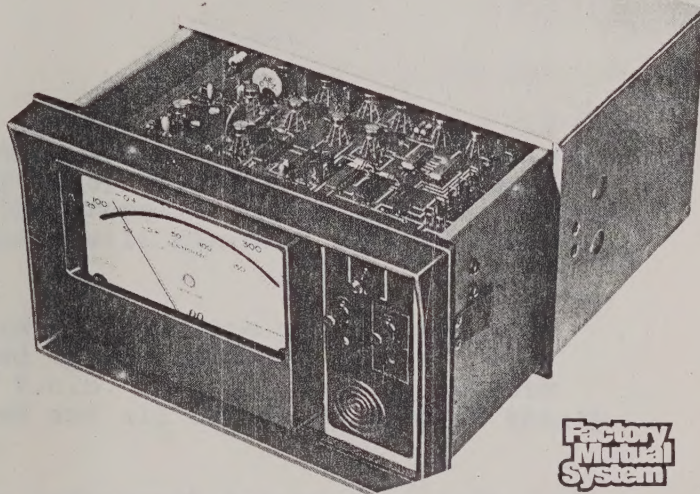


PRODUCT SAVER MODEL 012005

HIGH/LOW TEMPERATURE LIMIT CONTROL AND ALARM SYSTEM

The Productsaver is an indispensable, bi-directional temperature limit controller and alarm system to protect product and process from high and low temperatures. It is designed for applications where temperature must be maintained within prescribed limits and where extreme temperature conditions will ruin the process or equipment.

- Positive sensor break for product protection
- Visual and audible alarms with contact closures for individual alarm system
- Establishes *both* high and low temperature limits
- Selectable operating characteristics provide expanded usage
- Tamper-resistant set point adjustments for your protection
- High electrical noise immunity for heavy industrial applications
- Fully solid state for increased reliability



**Factory
Mutual
System**

LISTED BY FACTORY MUTUAL

Specifications — 012005

INPUT: Thermocouple, type T; copper/constantan. Not affected by thermocouple resistances of up to 1000 Ohms. Must be specified when ordering.

RANGE: -125F to +375F with equivalent C scale (standard). Optional ranges available.

MEASURING/ALARM ACCURACY: $\pm 1/4\%$ typical.

OUTPUTS: Visual — Separate alarm (yellow), 'high limit' (red) and 'low limit' (green) warning lights. Audible — Pulsing 2800 Hz, 70 db warning tone. Contacts — Separate 'alarm', 'high limit' and 'low limit' SPDT contacts, rated 4A @ 115vac.

SENSOR BREAK/FAILSAFE PROTECTION: Special circuit provides full-scale temperature indication, turns on 'alarm' light and turns off 'high' and 'low' limit contacts.

COLD JUNCTION COMPENSATION: Precision oven type stabilization.

ALARM SET POINTS: Screwdriver-adjustable high-resolution ($\pm 0.2\%$) potentiometers. Adjustable from front panel.

INDICATION: 6" (15.4cm) meter displays temperature, or set point levels when 'high' or 'low' pushbuttons are depressed at front panel.

ALARM REPEATABILITY: $\pm 0.1\%$.

HYSTERESIS: Less than $\pm 0.05\%$.

OPERABLE AMBIENT RANGE: +32F to +131F (0C to +55C).

TEMPERATURE EFFECT: Less than $\pm 0.01\%$ /deg F. (from 77F) ($\pm 0.02\%$ /°C) over operating range.

MAXIMUM POWER REQUIREMENTS: 117vac 50/60 Hz, 10 volt-amperes maximum.

LINE VOLTAGE EFFECT: Less than $\pm 0.03\%$ for $\pm 15\%$ line voltage changes within operating range.

HOUSING: Panel mounting aluminum case, suitable for bench service.

CONNECTORS: Screw type barrier strips.

DIMENSIONS: 5.8" (14.73cm) high, 9.6" (24.38cm) wide and 8.4" (21.34cm) deep. Protrudes 7.2" (18.29cm) behind mounting panels.

WEIGHT: 6.5 lbs (2.95kg).

Automatic Control Systems Division / Thermotron Industries Inc.

468 Cleveland Avenue, Holland, Michigan 49423 USA

616-392-1492

T.W.X. 810-292-6164

RECOMMENDED SPARE PARTS LIST

Thermotron recommends that its customers maintain a minimum quantity of spare parts. These parts are essential to the proper care and maintenance of your equipment, which will minimize unscheduled down time.

We strive to maintain a complete parts inventory and will be pleased to serve you if we can. All parts are shipped f.o.b. Holland, Michigan unless otherwise specified and all terms are cash in thirty (30) days.

If you require any additional information concerning parts, please contact our Parts Department for further information.

Note: When ordering parts, it is necessary to refer to the equipment serial number.

Parts Department
THERMOTRON CORPORATION
Holland, Michigan
Phone: 616/392-1492
At night: 616/392-1498

RECOMMENDED SPARE PARTS LIST

SM-16C and SM-32C Chambers

Part No.	Computer No.	Nomenclature	Qty. Per Chamber
42BE35AF	500096	Contactactor	2
42BE15AF	570831	Contactactor	3
151010	151010	Thermocouple	1
151012	151012	Thermocouple	1
756-K73-C27	565889	Switch	1
7562K53-C27	565870	Switch	1
32R2911T	567490	Lamp, Neon Pilot	1
100A	556294	Lamp, Chamber	1
EL1130	539462	Heater, Chamber	1
D213-001-415	533510	Heat Link	1
D2425	555751	Relay, Solid State	2
P70EA-6	567806	Switch, Pressure	3
P70CA-1	567792	Switch, Pressure	1
032-S	562774	Drier	1
163-F	562758	Drier	1
GR-1-ZP	580373	Valve	1
GR-1-Z	580411	Valve	1
228RB-220/1/60	549115	Solenoid	2
A3F1	549425	Solenoid	1
70625-023	580446	Valve, Expansion	1
189519	580454	Valve, Expansion	1
83388-02	580462	Valve, Expansion	1
T-4289	526123	Thermo*Tech, 2 oz.	1
15663	578131	Can Valve, Thermo*Tech	1
AB 1R042N	569175	Motor	1

GENERAL DESCRIPTION

This manual is provided to acquaint the operator with Thermotron equipment. The enclosed schematics will enable an understanding of how the various conditions and control functions are achieved. Thermotron engineering and "know how" are built into each assembly of environmental test equipment. This assures dependable operation of specific functional tests. Minimum maintenance will be achieved through periodic checks and proper care.

This chamber is completely self-contained and interconnected, capable of producing and maintaining the environmental conditions outlined. The materials, component parts, mechanical assemblies and workmanship used in the construction of this chamber are of the best commercial quality. All protective features normally incorporated in electrical and mechanical apparatus of this type have been used. The system is completely safety interlocked to prevent damage to the chamber in case of failure of any part.

EXTREME TEMPERATURE WARNING

This equipment is designed to operate at extreme high and low temperatures. Care should be taken to prevent exposure (opening the door or putting a hand through a port) at temperatures other than near ambient.

GENERAL DESCRIPTIONPOWER:

The chamber is designed to operate on the specific service supplied by the customer. The source of power necessary for the operation of the chamber terminates at the main power terminal block located inside the electrical compartment.

All of the major components requiring large amounts of current are operated from the main power source. Each circuit has its branch circuit protection. The control circuit operates on 115 volts. (Refer to electrical schematic.)

Control function switches, equipped with neon indicating lights, are readily accessible, providing a means of selecting the desired operating conditions.

All electrical components, whenever possible, are contained in a separate panel. All wiring is identified and either laced or enclosed in conduit. All circuits are protected with heat links or fuses. Electrical system meets N.E.M.A. standards.

HIGH VOLTAGE WARNING

This equipment is supplied with a high voltage power source and should be serviced or adjusted only by qualified personnel.

INSTALLATION INSTRUCTIONS

To insure proper operation, Thermotron chambers should be installed on a solid level foundation. Shim base of chamber as necessary to achieve this.

NOTE: In moving or relocating the chamber, NEVER tip more than 45 degrees without special instructions from the manufacturer.

ELECTRICAL:

Refer to the electrical schematic and provide proper power supply.

CO₂ COOLING OPTION: (As applicable)

Connect a clean, dry supply of CO₂ (1,000 PSI maximum) to the inlet side of the CO₂ control solenoid valve. (Insulate the piping from the supply to the chamber CO₂ valve.)

NOTE: A high pressure relief valve should be connected to this line to relieve pressure if CO₂ is trapped in the line. Connect a CO₂ vent exhaust line (of the same size diameter as vent) to the vent connection provided. This line should be as short as practical and with as few bends as possible, to prevent back pressure.

LN₂ COOLING OPTION: (As applicable)

Connect a clean, dry supply of LN₂ at 30 P.S.I. to the inlet side of the LN₂ control solenoid valve. (Insulate piping from the supply to the chamber LN₂ valve.)

NOTE: A high pressure relief valve should be connected to this line to relieve pressure if LN₂ is trapped in the line. Connect an LN₂ vent exhaust line (of the same size diameter as vent) to the vent connection provided. The line should be as short as practical and with as few bends as possible, to prevent back pressure.

COOLING

TEMPERATURE OPERATION:

When operating this chamber for temperature simulation, the mechanical cooling is accomplished by a Thermotron cascade refrigeration system. The system consists of two interdependent refrigeration systems arranged to operate in unison in conjunction with a cascade condenser. The refrigerant 13 system (low temperature) is the primary and the refrigerant 502 system (high temperature) is the secondary cooling system. The cascade condenser is of concentric tube construction (tube within a tube) which functions as the condenser section of the R-13 system and the evaporator section of the R-502 system. This type of refrigeration system is designated as a cascade system.

Basically, the system operates in the following manner: The low temperature, R-13 unit, removes heat from the interior of the chamber and passes it to the cascade condenser where it is picked up by the high temperature R-502 system. This heat is passed to an air cooled condenser in the R-502 unit where the heat is removed by passing air through the air cooled condenser.

A closer look at the R-13 system will reveal the following changes taking place in the low temperature system. Low pressure, heat laden R-13 vapor is compressed by the compressor to a high pressure vapor. This high pressure vapor passes through the discharge service valve, desuperheater and the cascade condenser. Excess heat (commonly referred to as the heat of compression) is removed by the desuperheater. The major portion of the heat is removed from the high pressure vapor in the cascade condenser. The condenser removes a sufficient amount of heat to change the refrigerant from a high pressure vapor into a high pressure liquid. The high pressure liquid is then piped through the full flow filter drier which removes any moisture present in the system. The high pressure liquid then passes through the capillary tube.

The capillary tube, being a restriction in the liquid line, divides the refrigeration system into a high and low pressure side. The high pressure liquid, in passing through the capillary tube, changes state to a low pressure liquid. The low pressure liquid enters the chamber fin coil where it absorbs heat from the chamber. In absorbing the heat, the low pressure liquid changes state to a low pressure vapor. This low pressure vapor is returned to the suction side of the compressor through the suction line service valve and the cycle repeats.

Another possible path is through the injection expansion valve circuit. This expansion valve senses the heat of the suction gas as it is returned to the compressor. When this temperature is above the designed level, the injection valve opens admitting a cold liquid to the stream of hot suction gas returning to the compressor. This valve will modulate to control the temperature of the returning gas. When returning suction gas is cooler, the injection valve will shut OFF.

COOLING

TEMPERATURE OPERATION: (Continued)

If the operating pressure is above 235 PSI, part of the refrigerant is relieved through the bypass solenoid to the vapor tank. This refrigerant is slowly returned to the suction side of the R-13 compressor through the return line. This "dumping" process will continue until the operation pressure drops below 235 PSI.

The function of the refrigerant 502 secondary cooling system is to provide cooling for the cascade condenser, the dehumidify coil and a portion of the chamber fin coil (during humidity testing only). The high temperature R-502 system compressor compresses low pressure, heat laden vapor into a high pressure vapor. This high pressure vapor passes through the air cooled condenser where heat is removed as it passes through the fin coils. As the heat is removed, it changes state to a high pressure liquid. This high pressure liquid passes through the full flow filter drier. The drier removes any moisture that may be present in the system. The high pressure liquid then travels through a sightglass (liquid indicator) to the R-502 expansion valve. This valve modulates to control the flow of liquid R-502 into the evaporator section of the cascade condenser by measuring and maintaining a predetermined superheat of the R-502 vapor leaving the cascade. In this manner, the capacity requirements of the compressor are kept in balance with the system. In absorbing the heat from the R-13 system in the cascade condenser, the low pressure R-502 liquid expands and changes to a vapor.

This low pressure vapor is returned to the suction side of the R-502 compressor through the R-502 suction line service valve. This completes the R-502 cycle.

Both the R-13 and R-502 compressors are connected in parallel when the TEMPERATURE/HUMIDITY switch is in the TEMPERATURE position and will operate whenever the HEAT/COOL switch is in the COOL position. Cooling effect begins to lower the chamber temperature. When cooling demand is satisfied, the bypass solenoid is energized (open) through the solid state relay, which also turns ON the heater. At least 50% of the refrigerant will be dumped into the receiver tank. The heating will now override the cooling. The compressors continue to operate in a bypass condition (low cooling). With another cooling demand from the instrument, the sequence will repeat.

COOLING

HUMIDITY OPERATION:

When operating this chamber for humidity simulation, the mechanical cooling is accomplished by the R-502 refrigeration system. With the TEMPERATURE/HUMIDITY switch in the HUMIDITY position, the R-13 system will not be operating. The function of the R-502 refrigeration system during humidity operation is to provide chamber cooling by utilizing a portion of the fin coils and provide dehumidification by means of the dehumidify coil.

The compressor compresses low pressure, heat laden vapor into a high pressure vapor. This high pressure vapor passes through the air cooled condenser where heat is removed as it passes through the fin coils. As the heat is removed, it changes state to a high pressure liquid. This high pressure liquid passes through the full flow filter drier which removes any moisture that may be present in the system. The high pressure liquid then travels through a sightglass (liquid indicator) to the expansion valve. Only a small amount of the liquid flows through the expansion valve. The major portion of the liquid will flow through the dehumidify coil and the humidity cool solenoid, dependent upon the system demand. The humidity cool solenoid is always energized (open) during humidity testing and the liquid will flow through the humidity capillary tube.

The capillary tube, being a restriction in the liquid line, divides the refrigeration system into a high and low pressure side. The high pressure liquid, in passing through the capillary tube, changes state to a low pressure liquid. The low pressure liquid enters the chamber fin coil where it absorbs heat from the chamber. In absorbing the heat, the low pressure liquid changes state to a low pressure vapor. This low pressure vapor is returned to the suction side of the compressor through the suction line service valve and the cycle repeats.

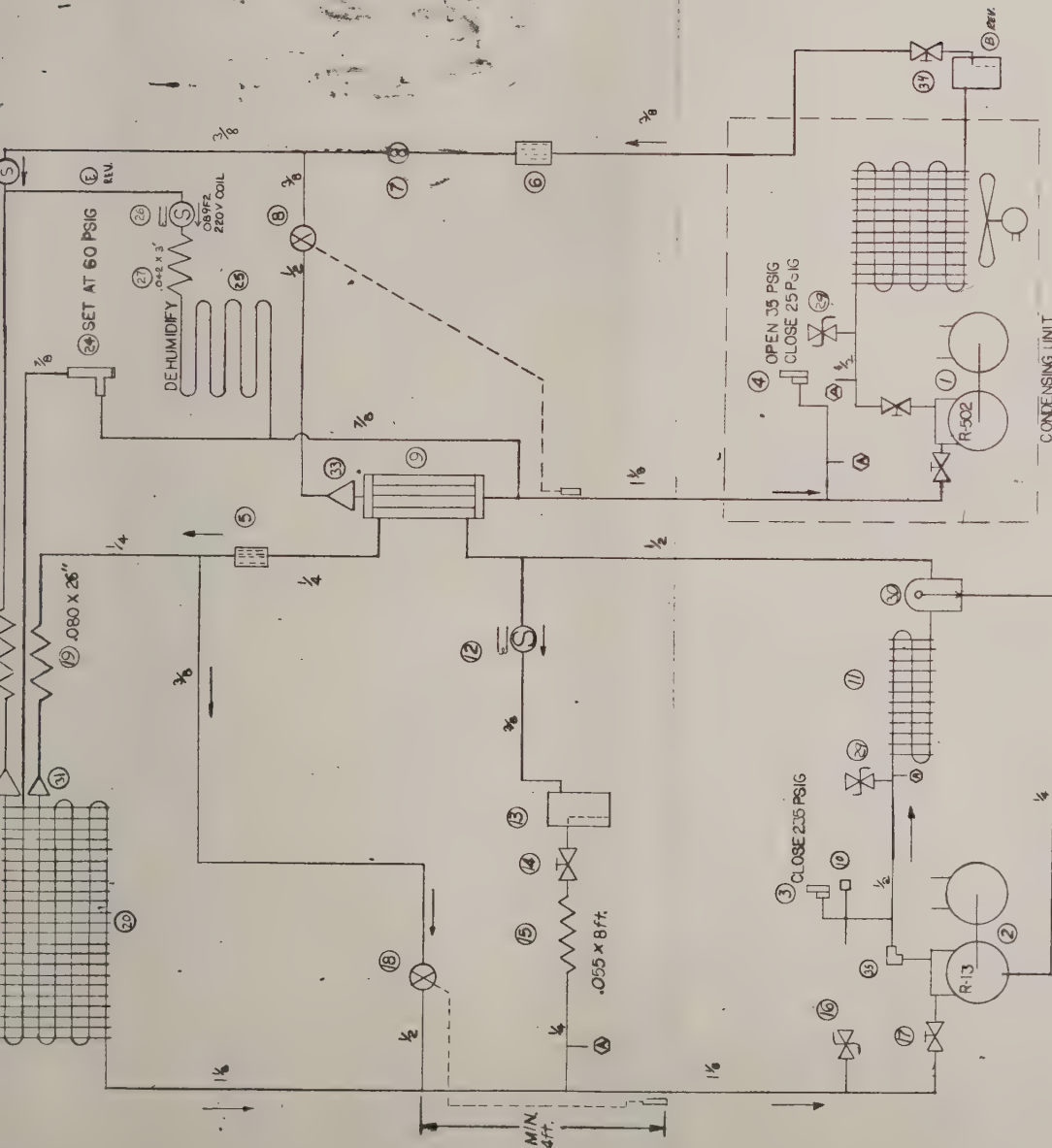
The liquid refrigerant may also flow through the dehumidify expansion valve and the dehumidify coil. The amount of liquid flowing into the coil is regulated by the thermal-electric expansion valve which is controlled through the control circuit. As the cool liquid refrigerant flows into the coil, moisture is collected on the coil. In the coil, the liquid refrigerant expands and changes state to a vapor; thereby absorbing heat from the chamber. The heat laden vapor is returned to the compressor.

HIGH HEAT LIMIT

HUMIDITY GENERATOR HEAT LIMIT ADJUSTMENT:

The humidity heat limit should be adjusted to open at approximately +225°F. This will cause the humidity heat circuit to open if the humidity heater is energized when there is no water in the vapor generator, thus protecting the heater against burnout.

The heat limit is a manual reset type. Once the setting has been exceeded, the reset button must be manually depressed.



230/160

USE THERMOSTAT SETTING
OPEN 30°F CLOSE 38°F

 THERMOTRON CORPORATION HOLLAND, MICHIGAN 49423		NO. 1 1/16" 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2" 3" 3 1/2" 4" 4 1/2" 5" 5 1/2" 6" 6 1/2" 7" 7 1/2" 8" 8 1/2" 9" 9 1/2" 10" 10 1/2" 11" 11 1/2" 12" 12 1/2" 14" 15" 16" 18" 20" 22" 24" 26" 28" 30" 32" 34" 36" 38" 40" 42" 44" 46" 48" 50" 52" 54" 56" 58" 60" 62" 64" 66" 68" 70" 72" 74" 76" 78" 80" 82" 84" 86" 88" 90" 92" 94" 96" 98" 100"		CHANGE NO. 1 1/16" 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2" 3" 3 1/2" 4" 4 1/2" 5" 5 1/2" 6" 6 1/2" 7" 7 1/2" 8" 8 1/2" 9" 9 1/2" 10" 10 1/2" 11" 11 1/2" 12" 12 1/2" 14" 15" 16" 18" 20" 22" 24" 26" 28" 30" 32" 34" 36" 38" 40" 42" 44" 46" 48" 50" 52" 54" 56" 58" 60" 62" 64" 66" 68" 70" 72" 74" 76" 78" 80" 82" 84" 86" 88" 90" 92" 94" 96" 98" 100"		DATE 7-28-60 DRAWING NO. R-5247-12-19 SIZE X	
		DESCRIPTION SM-16C & 32C HUMIDITY		TOLERANCE SCALE MATERIAL FINISH DRAWN BY BN CHECKED BY RELEASED BY			

TERMINAL BLOCK - "E8"

* P3TRBI-8

CABLE "D"

THIS 7-COND CABLE RUNS FROM
THE SENSOR TERMINAL BLOCK TO THE
MH452 PROGRAMMER RECORDER.

CAUTION:

THIS CABLE MUST BE FASTENED
TO THE CHAMBER OUTER WALL AND
MUST BE KEPT AWAY FROM THE
CHAMBER LINEAR.

MH 452 P-R

NOTE: 1

1/2" THIN WALL *P3CONIEMT-1 (AS REQ'D)
1/2" PULLING ELBOW X 90° *P3CNRIPEL-1 (2-REQ'D)
1/2" THIN WALL CONNECTOR *P3CNRIEMT-1 (4-REQ'D)
1/2" CHASE NIPPLE *P3CHAI-1 (2-REQ'D)

CABLE "C"

THIS 4-COND CABLE RUNS FROM
THE MH 452 P-R ATTENUATION BOARD
* I-2076 TO THE I-2071 CONTROLLER

64" on SM-4
68" on SM-8, 16, 32 } → *

MH 452 P-R POWER WIRES

(1) #16 AWG GREEN (G)

(1) #16 AWG WHITE (X2)

(1) #16 AWG RED (1)



THERMOTRON
CORPORATION

HOLLAND, MICHIGAN 49423

Diagram illustrating the assembly of a chamber, showing various components and their installation points:

- FEED-THROUGH BUSHING**: Located at the top center of the chamber.
- SEV**: Located at the top right of the chamber.
- FOR**: Located below the SEV label.
- 1" 4-20**: Dimension indicating the size of the bolts used for assembly.
- BOLTS W/ LARGE FLAT WASHER - LOCK WASHER & NUT ON INSIDE OF CHAMBER OUTER WALL.**: Instruction for the placement of the bolts.
- STANDARD INSTRUMENTATION**: Label on the front panel of the chamber.
- HOLD DOWNS**: Label pointing to the bottom of the chamber structure.
- 18-1**: Label pointing to a component on the left side of the chamber.

FOR SENSOR HOLDING METHOD

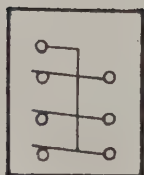
NOTES:

1: HEYCO BUSHING #P3BSH2-2

DRILL .500" HOLE FOR BUSHING
AS CLOSE TO CHAMBER OUTER WALL
AS POSSIBLE.

CHANGES	DATE	BY	CHK'D	NO.	CHANGES	DATE	BY	CHK'D	TOLERANCE	DESCRIPTION	SIZE
									SCALE	ACCESSORY (5247-12) ASSEMBLY (FOR "SM" CHAMBERS)	DRAWING NO. E-5247-13-63
									MATERIAL		
									FINISH		
									DRAWN BY		
									CHECKED BY	DATE	X
									RELEASED BY	DATE	

ELECTRICAL SCHEMATIC SYMBOLS



Disconnect Switch



Fuse



Heater



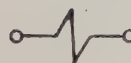
Chamber Interior Light



Panel Function Light

Energizing Coil
(Contactor, Timer, Relay, etc.)

Compressor Fan

Normally Open
ContactNormally Closed
ContactThermal Actuated
Switch (Heat & Cooling
Limits, etc.)Pressure Actuated
SwitchRefrigeration
Solenoid

HIGH HEAT LIMITHUMIDITY GENERATOR HEAT LIMIT ADJUSTMENT:

The humidity heat limit should be adjusted to open at approximately +225°F. This will cause the humidity heat circuit to open if the humidity heater is energized when there is no water in the vapor generator, thus protecting the heater against burnout.

The heat limit is a manual reset type. Once the setting has been exceeded, the reset button must be manually depressed.

INSTRUCTION MANUAL

**Dual Channel
Temperature/Humidity Controller
MODEL 012030**



THERMOTRON

THERMOTRON INDUSTRIES
Kollen Park Drive
Holland, Michigan 49423 U.S.A.
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GENERAL INFORMATION

This controller is designed to control temperature and humidity within a test environment. The controller provides an output to achieve controlled temperatures within a range of -100°F. to $+200^{\circ}\text{F.}$ (-73.3°C. to $+93.3^{\circ}\text{C.}$). The wet bulb output provides controlled relative humidities in the range of 20% to 95% R.H. as limited by a minimum dew point of $+35^{\circ}\text{F.}$ ($+1.67^{\circ}\text{C.}$) and a maximum dry bulb of $+185^{\circ}\text{F.}$ ($+85^{\circ}\text{C.}$).

The controller outputs are coupled to solid state relays. The solid state relays are zero voltage firing devices and allow a load to be energized with minimum RFI signals.

The sensor inputs are Type 'T' copper/constantan thermocouple wire. A sensor failure protection feature causes the controller temperature signal to be driven to the maximum upper scale value and the output to the OFF state.

With the S.P./TEMP switch in the S.P. position, the pointer will indicate the temperature set point by a ten-turn potentiometer. In the temperature position (spring return) the meter will monitor the test environment temperatures.

SPECIFICATIONS

Inputs:

Both dry bulb and wet bulb are thermocouple inputs Type 'T'.

Range:

-100°F. to +200°F. (-73.3°C. to +93.3°C.) standard.

Measuring Accuracy:

±1/4% typical. Guaranteed ±1% maximum.

Sensor Break/Failsafe Protection:

The controller turns OFF and the temperature indicator slews to maximum upscale value.

Cold Junction Compensation:

A highly accurate temperature transducer is arranged to provide a common ambient change offset to both the dry bulb and wet bulb circuitry. This arrangement eliminates any error that could occur by matching two separate compensating networks.

Indication:

Precision analog meter with a mirror scale and knife-edge pointer to permit accurate (anti-parallax) readings (±1/4% typical). Guaranteed ±1% maximum dry bulb and wet bulb indication is obtained by using the same meter, thus eliminating any error that could occur by using two separate indicating devices.

Set Point Provision:

Manual ten-turn potentiometer providing set point indication on the same analog meter is used for temperature indication.

Programming Provision:

Accepts 1 - 5 vdc analog set point signal from remote source. Loading at set point input is less than 150 nA.

Operating Range:

40°F. to 120°F.

Output:

Voltage pulse output for firing a zero cross-over solid state power switch.

ON State: 5.8 V to 7.0 vdc.

OFF State: 0 V to +0.4 vdc.

SPECIFICATIONS (Continued)

Output Loading:

Recommended 10 mA maximum load. Integral output current limit-
at 25 mA. (Output short circuit protection.)

CALIBRATION

EQUIPMENT REQUIRED:

1. Portable Potentiometer:
Type 'T' thermocouple calibration required. (Honeywell
2736 or equivalent.)
2. Digital Voltmeter:
Use a digital voltmeter of 0.1% accuracy. (Fluke 8000A or
equivalent.)
3. Thermocouple Extension Wire:
Six feet of Type 'T' thermocouple wire.

- WARNING -

**Power is ON when working on the controller and can cause
serious injury if accidentally touched. Also - be careful with
tools and circuit testing methods. Solid state devices can be
easily damaged if improper techniques or accidental shorting
results while making circuit tests.**

PROCEDURE:

1. With power OFF:
Make mechanical zero adjust (-100°F. on indicating meter)
with zero adjust screw on meter front. Accurate adjustment
is essential.
2. Connect power:
Apply 115 Vac to TB3. Allow controller to warm up approx-
imately 15 minutes before calibrating.
3. Adjust rj Network:
 - a. Connect digital voltmeter (DVM) positive (+) lead to TP1
and the negative (-) lead to TP2.

PROCEDURE (Continued)

- b. Adjust potentiometer P1 for a 0.500 volt indication on the DVM.
 - c. Connect DVM positive (+) lead to TP3 and the negative (-) lead to TP2.
 - d. Adjust potentiometer P2 for a 0.425 volt indication on the DVM.
 - e. Connect DVM positive (+) lead to TP1 and the negative (-) lead to TP2.
 - f. Readjust potentiometer P1 for a 0.0 volt indication on the DVM.
4. Dry Bulb Zero and Span Calibration:
- a. Disconnect the dry bulb measuring thermocouple (if present) from TB1 and connect portable potentiometer to the dry bulb input terminals with the six-foot length of thermocouple wire.
 - TB1-1: Blue insulated wire (copper “+”).
 - TB1-2: Red insulated wire (constantan “-”).
- NOTE: There is a small constantan wire permanently connected to TB1-2. When connecting the thermocouple wire to TB1-2, the two constantan wires MUST make good physical contact under the screw.
- b. Adjust portable potentiometer to -50°F.
 - c. Connect DVM positive (+) lead to TP5 and the negative (-) lead to TP4.
 - d. Adjust dry bulb “zero” potentiometer P3 for a 1.56 Vdc indication on the DVM.
 - e. Adjust portable potentiometer to +150°F. and record voltage as indicated on the DVM positive (+) lead on TP5 and the negative (-) lead on TP4.
 - DO NOT CHANGE THE PORTABLE POTENTIOMETER SETTING WHILE PERFORMING STEPS f. and g.
 - f. Connect DVM positive (+) lead to TP7 and negative (-) lead to TB2, terminal 1.
 - g. Adjust dry bulb “Δ gain” potentiometer P5 to the recorded voltage taken in Step e.
 - h. Adjust portable potentiometer to -50°F.

PROCEDURE (Continued)

- i. Adjust dry "zero" potentiometer P3 for a 1.56 volt indication on the DVM.
- j. Adjust portable potentiometer to +150°F.
- k. Adjust dry bulb "span" potentiometer P4 for a 4.23 Vdc indication on the DVM.

NOTE: Adjustment of P4 causes small magnitude changes in voltage indications while adjustment of P3 causes much larger voltage change. Also, zero and span adjustment Steps h through k must be repeated once or twice to neutralize a small interaction between zero and span adjustment.

5. Meter Zero and Span:

- a. Adjust portable potentiometer to -50°F.
- b. Place W.B./D.B. switch to D.B. position.
- c. Place S.P./TEMP switch in TEMP position.
- d. Adjust potentiometer P12 to align the meter pointer with the -50°F scale position.
- e. Adjust portable potentiometer to +150°F.
- f. Adjust potentiometer P11 to align the meter pointer with the +150°F. scale position.
- g. Disconnect portable potentiometer, the six-foot length of thermocouple wire, and the DVM from the circuitry.
- h. Connect the dry bulb measuring thermocouple to the dry bulb input terminals.
TB1-1: Blue insulated wire (copper "+")
TB1-2: Red insulated wire (Constantan "-").

NOTE: When connecting the thermocouple wire to TB1-2, the measuring thermocouple wire MUST make good physical contact with the existing (permanent) constantan wire under the screw.

6. Wet Bulb Zero and Span Calibration:

- a. Disconnect the wet bulb measuring thermocouple (if present) from TB1 and connect the portable potentiometer to the wet bulb input terminals with the six-foot length of thermocouple wire.

TB1-3: Blue insulated wire (copper "+")
TB1-4: Red insulated wire (constantan "-").

PROCEDURE (Continued)

NOTE: There is a small constantan wire permanently connected to TB1-4. When connecting the thermocouple wire to TB1-4, the two constantan wires **MUST** make good physical contact under the screw.

- b. Connect DVM positive (+) lead to TB6 and the negative (-) lead to TP4.
- c. Adjust portable potentiometer to -50°F.
- d. Adjust wet bulb "zero" potentiometer P6 for a 1.56 Vdc indication on the DVM.
- e. Adjust portable potentiometer to +150°F. and record voltage as indicated on the DVM (positive (+) lead on TP6 and the negative (-) lead on TP4).

DO NOT CHANGE THE PORTABLE POTENTIOMETER SETTING WHILE PERFORMING STEPS f AND g.

- f. Connect DVM positive (+) lead to TP8 and negative (-) lead to TB2, terminal 1.
- g. Adjust wet bulb "Δ gain" potentiometer P8 to the recorded voltage taken in Step e.
- h. Adjust portable potentiometer to -50°F.
- 6. i. Adjust wet bulb "zero" potentiometer P6 for a 1.56 volt indication on the DVM.
- j. Adjust portable potentiometer to +150°F.
- k. Adjust wet bulb "span" potentiometer P7 for a 4.25 Vdc indication on the DVM.

NOTE: Adjustment of P7 causes small magnitude changes in voltage indications while adjustment of P6 causes much larger voltage change. Also, zero and span adjustment, Steps h through k, must be repeated once or twice to neutralize a small interaction between zero and span adjustment.

7. Meter Zero and Span:

- a. Adjust portable potentiometer to -50°F.
- b. Place S.B./D.B. switch in D.B. position.
- c. Place S.P./TEMP switch in the TEMP position.
- d. Meter indication should correspond to -50°F. meter position.

PROCEDURE (Continued)

- e. Adjust portable potentiometer to +150°F. Meter indication should correspond.
- f. If Step d and Step e do not indicate proper meter positioning with the potentiometer input signals, recheck the calibration procedure from the beginning.
- g. Disconnect portable potentiometer, the six-foot length of thermocouple wire and the DVM from the circuitry.
- h. Connect wet bulb measuring thermocouple to the wet bulb input terminals.

TB1-3: Blue insulated wire (copper “+”)

TB1-4: Red insulated wire (constantan “-”).

NOTE: When connecting the thermocouple wire to TB1-4, the measuring thermocouple wire **MUST** make good physical contact with the existing (permanent) constantan wire under the screw.

8. Feedback Network Adjustment:

Two potentiometers remain to be adjusted. The wet bulb amplitude potentiometer P9 and the dry bulb amplitude potentiometer P10 provide proportioning-like action to the controller. Potentiometer P9 will affect the wet bulb portion of the controller and potentiometer P10 will affect the dry bulb portion of the controller. The adjustment of these is not a calibration adjustment but rather an operations adjustment. Correct adjustment of these potentiometers can only be determined when the total system is in operation. As a starting point, position both potentiometers half way between full C.W. and full C.C.W. rotation.

The following figures and descriptions are intended to give an understanding of how the amplitude feedback potentiometers affect the operational response of the total system.

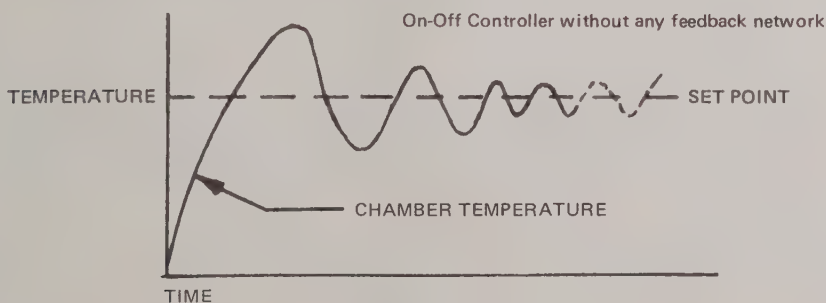


FIGURE 1

PROCEDURE (Continued)

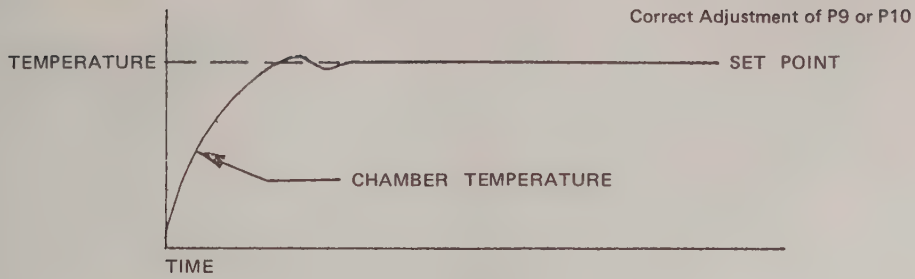


FIGURE 2

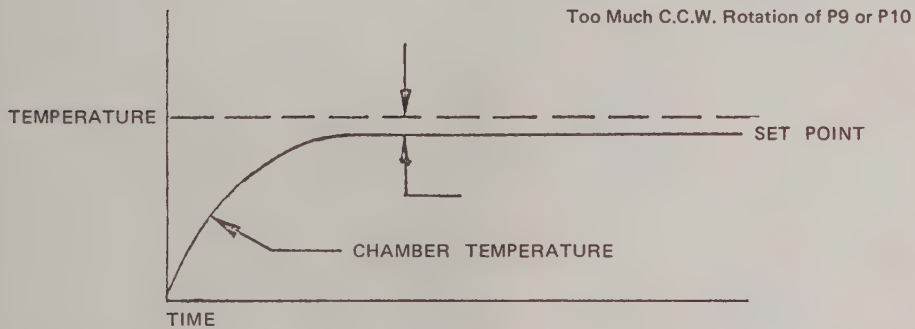


FIGURE 3

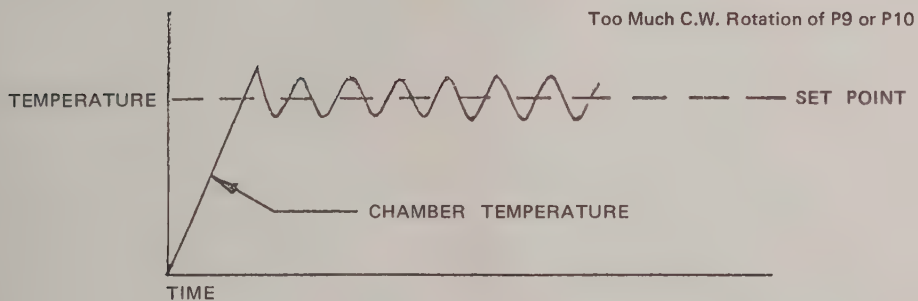
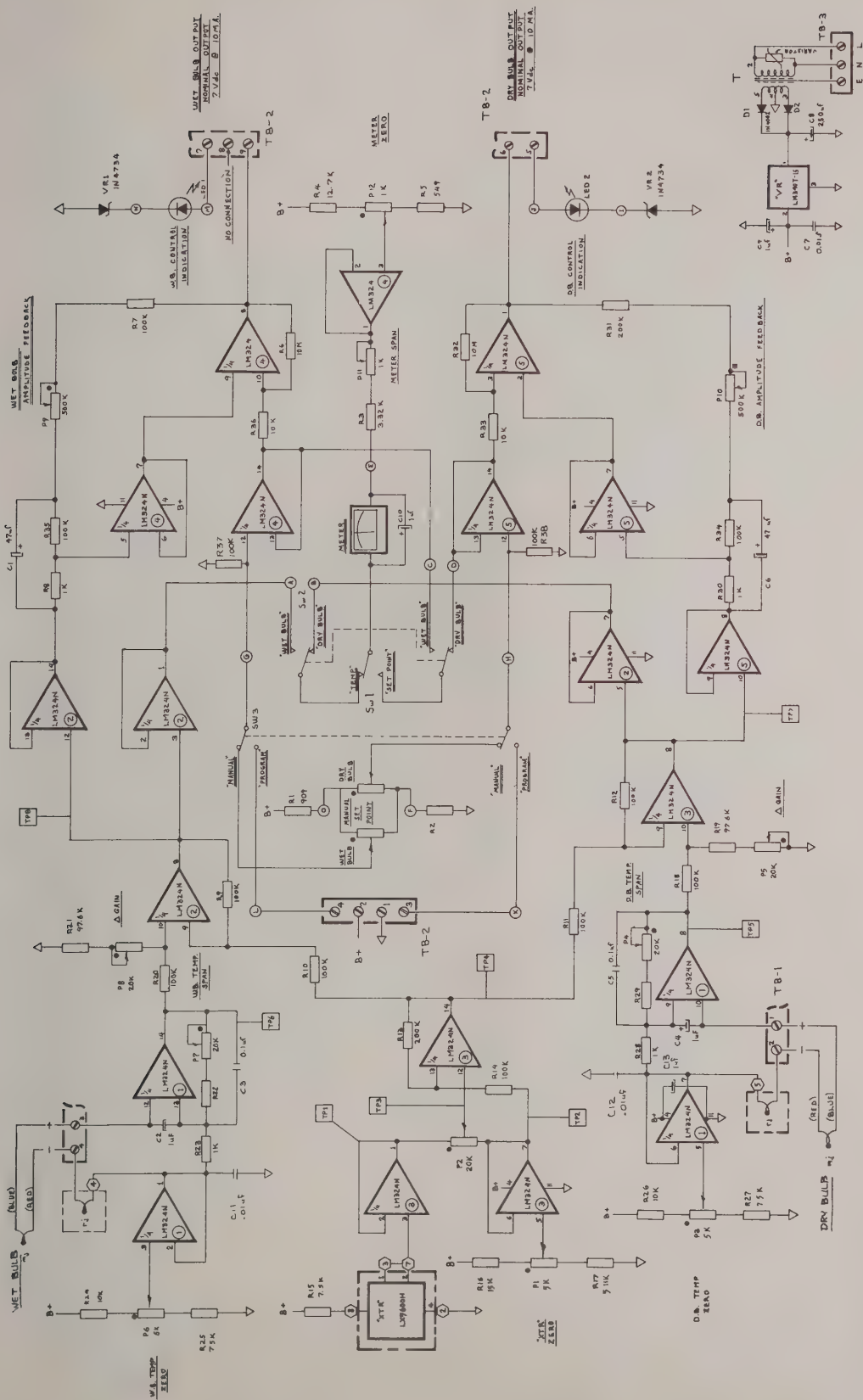
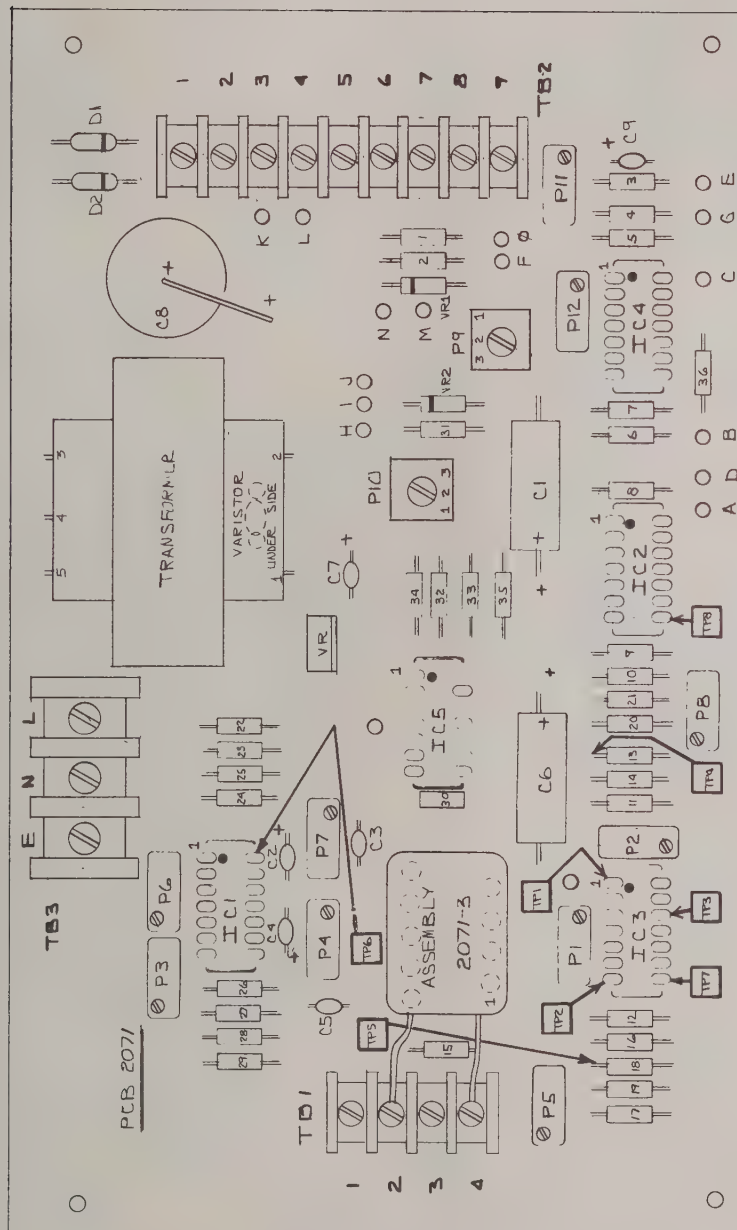


FIGURE 4

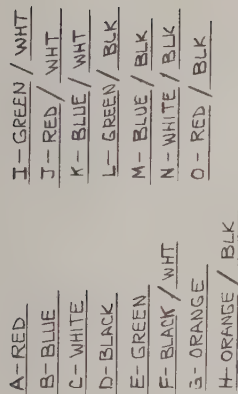
Full C.C.W. rotation of P9 and P10 will give maximum proportioning action and fastest ON-OFF cycle rate. Likewise, full C.W. rotation of P9 and P10 will give minimum proportioning action and slowest ON-OFF cycle rate.



SPD HUMIDITY CONTROLLER

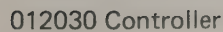


PCB NO. 2071 COMPONENT LAYOUT



ALL JUMPER: NOT
NOTED ARE TO BE
22 GA. BLACK

FRONT PANEL TO PCB CONNECTION



Accessory #5247-12 adds a Honeywell 452 for cam programming and recording to the Standard Products "SM" chamber line.

The Honeywell 452 program recorder is MTG on the chamber left side (Reference Drawing No. E-5247-13-63(X)).

Recording sensors are added within the Standard Wick Tank. (Reference Drawing No. E-5247-13-53(Y)).

Electrical wiring information required for connection of the Accessory is shown with Drawing No. E-5247-13-62(X).

OPERATION OF SYSTEM

Humidity programming is accomplished by programming the dry bulb set point and the wet bulb set point from a Honeywell 452 program-recorder.

Placing the controllers "Program/Manual" set point selector switch in the "Program" position allows the controller to accept set point signal from the Honeywell 452 programming potentiometers.

The program profile is cut on circular cams (Part No. P4CAM1-1) which are graduated from 0 to 100 percent.

The desired program temperature to be run is found on a temperature vs. percentage of span table and converted into a percentage value.

The cam is then cut at this percentage value.

Dry Bulb and Wet Bulb Cams are then synchronized and deliver their set point signals to the controller for required humidity conditions. The recording portion of the Honeywell 452 will record the dry bulb temperature and the difference between dry and wet bulb temperatures.

Calibration information is outlined in: "CALIBRATION OF ACCESSORY 5247-12".

CALIBRATION OF ACCESSORY #5247-12

6/2030

Calibrate the ~~F-2071~~ controller per standard calibration procedure.

Calibrate the recording portion of the MH 452 per the MH 452 manual and by using the temperature vs. resistance characteristic for Degussa RTD's. (This is the characteristic of Thermotron sensor #T3BLB-1 and #T3BLB-2.)

Calibrate the programming portion of the MH 452 as follows:

1. With power off; remove the green wire on terminal 1 and the white wire on terminal 4 from the MH 452 slidewire terminal block.
2. Cut a cam for positioning the cam follower arm at the 0% point and at the 100% point.
3. Place the cam on the dry bulb hub and position the cam follower at the 0% position.
4. While measuring the resistance between terminal 4 and terminal 5 of the programming terminal strip, adjust the cam follower zero screw for a 10 OHM reading.
5. Place the cam on the wet bulb hub and position the cam follower at the 0% position.
6. While measuring the resistance between terminal 1 and terminal 2 of the programming terminal strip, adjust the cam follower zero screw for a 10 OHM reading.
7. Reconnect the green wire on terminal 1 and the white wire on terminal 4 which were taken off the MH 452 slidewire terminal block.
8. Position controller "Program/Manual" switch in the "Program" position.
9. Remove the wet bulb and dry bulb thermocouples from the controller terminal block "TB-2".
10. Position chamber "Heat/Cool" mode switch in "Heat" position.
11. Apply power by placing the "Temperature/Humidity" mode switch in the "Temperature" position.

(Steps 8 through 11 will allow calibration of the Honeywell 452 without chamber conditioning).

12. Place test cam (step 2) on wet bulb hub (step 5) and position the cam follower at the 0% position.
13. Connect a digital voltmeter (of 0.1% accuracy) position (+) lead to terminal (4) and negative (-) lead to terminal (1) of I-2076 attenuator board (MTG inside MH 452.)
14. Adjust pot R3 for a 1.00 volt reading on the DVM.
15. Position the cam follower at the 100% position and adjust pot R4 for a 5.00 volt reading on the DVM.

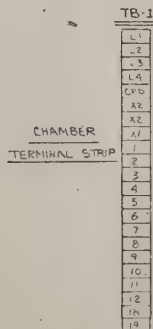
NOTE: Pot R3 and R4 will interact upon one another, therefore, repeat step 14 and 15 until voltage indications are verified at 1.00 volt and 5.00 volts.

16. Place test cam on dry bulb hub and position the cam follower at the 0% position.
17. Connect the DVM positive (+) lead to terminal (3) and negative (-) lead to terminal (1) of I-2076 attenuator board.
18. Adjust pot R1 for a 1.00 volt reading on the DVM.
19. Position the cam follower at the 100% position and adjust pot R2 for a 5.00 volt reading on the DVM.

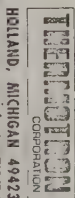
NOTE: Pot R1 and R2 will interact upon one another, therefore, repeat step 18 and 19 until voltage indications are verified at 1.00 volt and 5.00 volts.

20. Remove test cam and install program cams on dry bulb and wet bulb cam hubs, synchronize cams.
21. Reconnect the wet bulb and dry bulb thermocouples to the controller terminal block "TB2".
22. Position "Temp/Humidity" mode switch in the "Off" position.
23. Position controller "Program/Manual" selector switch in the "Program" position.
24. Position chamber "Heat/Cool" switch in "Cool" position.
25. Position "Temperature/Humidity" mode switch in the "Humidity" position and the system is under way.

INSTALL JUMPERS TO MATCH POWER SUPPLY



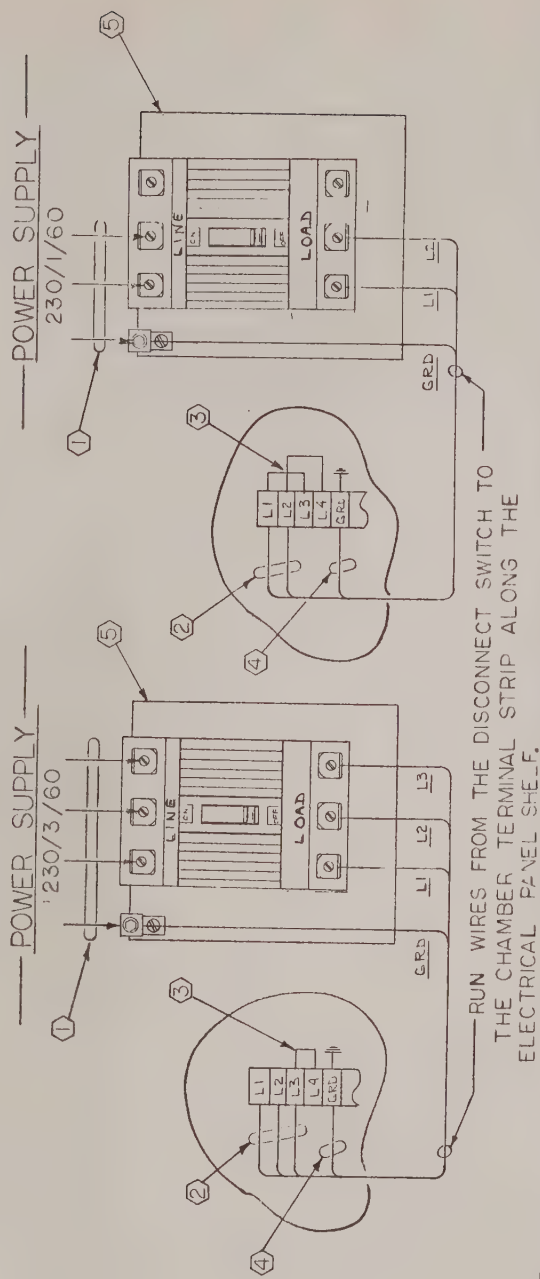
INSTRUMENTATION SYSTEM WIRING DWG. E-5247-13-40-X



HOLLAND, MICHIGAN 49423

TELETYPE CORPORATION

ITEM	DESCRIPTION	S4, S8, SWS, SWS, SMBC	S16 S32	SM16S, SM16 C, SM32S, SM32C
1	POWER SUPPLY WIRES: A. CUSTOMER TO RUN FOR STANDARD 230 / 60 OR 230 3 60" SUPPLY B. SPD TO RUN WHEN TRANSFORMER ACCESSORY IS ALSO OPTIONED. (SPD TO ALTER TRANSFORMER ACCESSORY WIRING INFORMATION BY RUNNING TRANSFORMER SECONDARY WIRES TO THE LINE SIDE OF THE DISCONNECT SWITCH AND THEN RUN WIRES FROM THE LOAD SIDE OF THE DISCONNECT SWITCH TO THE CHAMBER TERMINAL BLOCK)			
2	POWER WIRES FROM LOAD SIDE OF DISCONNECT SWITCH TO CHAMBER TERMINAL BLOCK: 230 / 1 / 60 230 / 3 / 60	* 8 AWG THHN BLACK * 10 AWG THHN BLACK	* 6 THHN BLACK * 8 THHN BLACK	* 6 AWG THHN BLACK * 8 AWG THHN BLACK
3	JUMPER WIRES: 230 / 1 / 60 230 / 3 / 60	* 12 AWG THHN BLACK * 12 AWG THHN BLACK	* 10 THHN BLACK * 10 THHN BLACK	* 10 AWG THHN BLACK * 10 AWG THHN BLACK
4	GROUND WIRE: 230 / 1 / 60 230 / 3 / 60	* 10 AWG THHN GREEN * 10 AWG THHN GREEN	* 10 THHN GREEN * 10 THHN GREEN	* 10 AWG THHN GREEN * 10 AWG THHN GREEN
5	MOUNTING BRACKET, DISCONNECT SWITCH, AND HARDWARE — SEE BILL OF MATERIAL # 5247-22-4			



 THERMOTRON CORPORATION HOLLAND, MICHIGAN 49423		DATE: 11-1-60 DRAWN BY: K.H.S. CHECKED BY: [] RELEASED BY: []	
		MATERIAL: 5247-22-4 FINISH: [] SCALE: [] TOLERANCE: []	
DESCRIPTION: DISCONNECT SWITCH WIRING INFORMATION		DATE: 11-1-60 DRAWN BY: K.H.S. CHECKED BY: [] RELEASED BY: []	

115/1/60

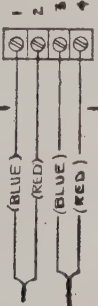
— LINE
— NEUTRAL
— EARTH



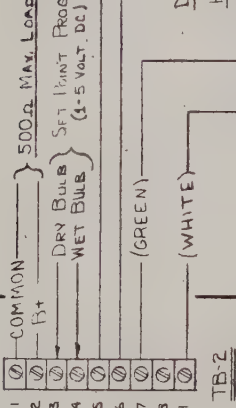
DRY BULB

TYPE T THERMOCOUPLES

WET BULB



CONTROLLER



DRY BULB
HEATER
OUTPUT

CRYDOM MODEL DZ4'S
SOLID STATE POWER SWITCH
(OR EQUAL)

WET BULB
HUM GENERATOR
OUTPUT

CRYDOM MODEL DZ4'S
SOLID STATE POWER SWITCH
(OR EQUAL)

(A) 4-CONDUCTOR 22GA

(B) 3-CONDUCTOR 22GA



THERMOTRON
CORPORATION

HOLLAND, MICHIGAN 49423

NO.	CHANGES	DATE	BY	CHANGED	NO.	CHANGES	DATE	BY	CHANGED	TOLERANCE	DESCRIPTION
1	REDAWN	11/24/60								SCALE	INSTRUMENTATION
										MATERIAL - RCF -	SYSTEM WIP-INC
										FINISH	
										DRAWN BY R. HOLLEY	
										CHECKED BY	
										RELEASED BY	

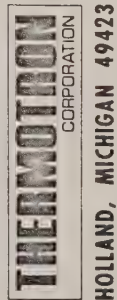
DATE 7/7/80
DRAWING NO. C 5247-13-2
DATE
DATE

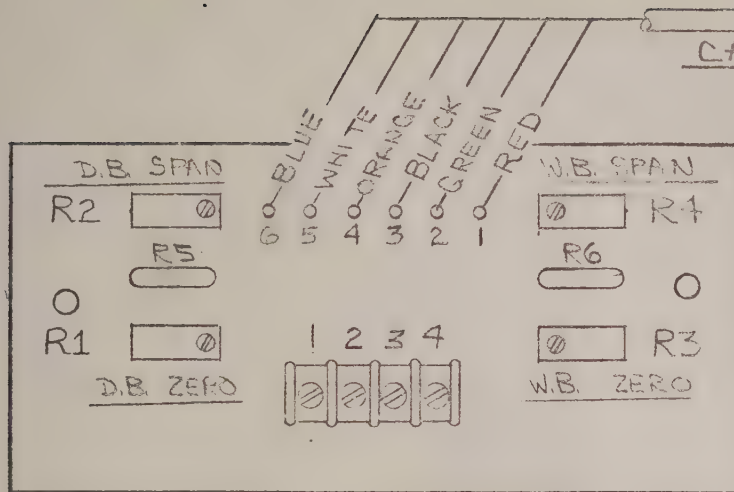
5/71

X

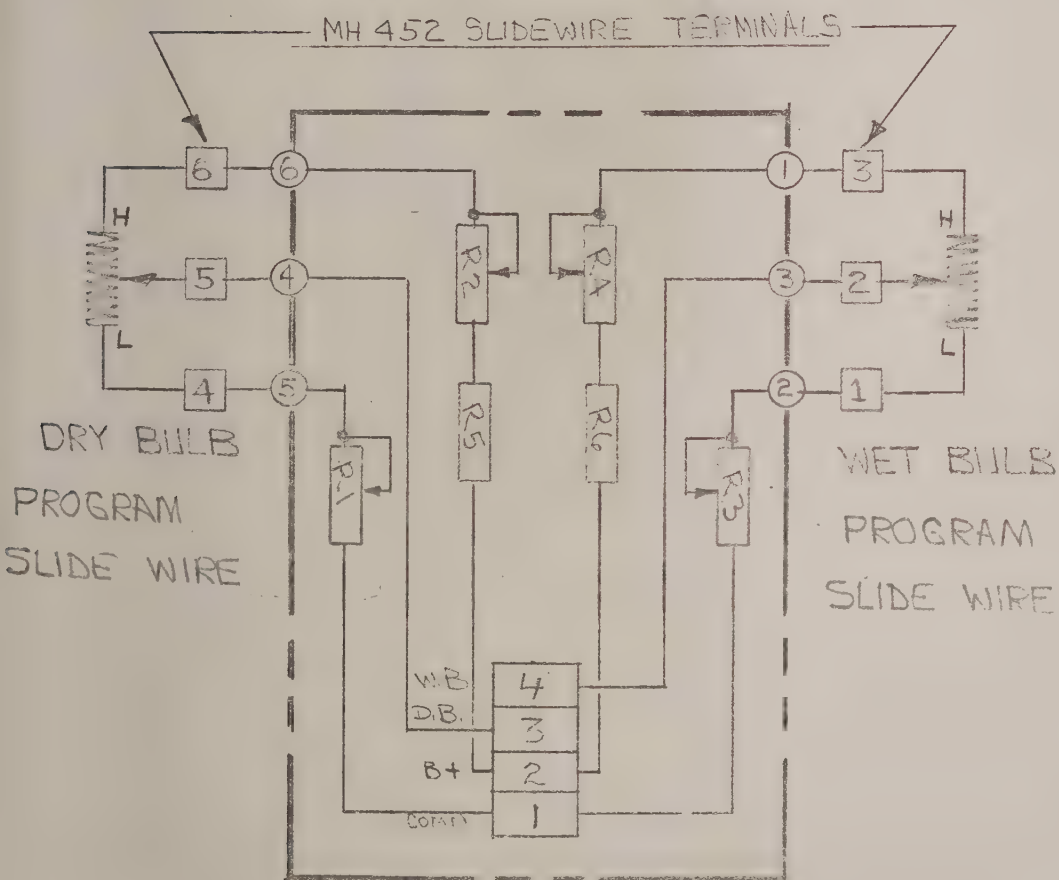
[illegible]

HONEYWELL 452 PROGRAMMER RECORDER

[illegible]



ITEM
R1-R4
R5-R6
PCB
TERMINAL
CABLE



SYM	DATE	CHANGE	BY
A			
B			
DRAWN BY	DATE	SCALE	APPROV
R. H. H. H.			

THERMOTRON PART NO	DESCRIPTION	MFG PART NO	P.O. No.	QTY
054002	500 Ω 25T POT	—	ACS	4
—	2.2K Ω 1/4 WATT RESISTOR 1%	2.2K 13	P.O. REQ #1070	2
I-2076	PRINTED CKT. BOARD	CUSTOM CKTS FOR I-2076	P.O. "	1
—	TERMINAL BLOCK	CURTIS/SEPCR-4	P.O. "	1
—	22GA. 6-COND CABLE	BELDEN 17-8446	P.O. "	25'



PART NO. 528118

SYM	DATE	CHANGE	BY	MATERIAL	THERMOTRON CORP. HOLLAND, MICHIGAN U.S.A.	POP	DRAWING NO.	1-2076-3 V
C								
D								
DESCRIPTION								

RESISTANCE TEMPERATURE TABLE

FOR

PLATINUM RESISTANCE THERMOMETER ELEMENTS
(100 ohms at 0°C/32°F)

Thermotron #I-2005A Thermotron #I-2010A Thermotron #I-2019A Degussa Sensors			Burns Sensors			YSI-Sosman, Model 4150 Series Sosman, Model 4100 Series		
Temperature		Resistance of Element (Ohms)*	Temperature		Resistance of Element (Ohms)*	Temperature		Resistance of Element (Ohms)*
°C	°F		°C	°F		°C	°F	
+380.0	+716	240.15	+380.0	+716	242.05	+380.0	+716	242.74
+360.0	+680	233.19	+360.0	+680	234.99	+360.0	+680	235.65
+340.0	+644	226.18	+340.0	+644	227.89	+340.0	+644	228.51
+320.0	+608	219.13	+320.0	+608	220.74	+320.0	+608	221.32
+300.0	+572	212.03	+300.0	+572	213.55	+300.0	+572	214.09
+280.0	+536	204.88	+280.0	+536	206.31	+280.0	+536	206.81
+260.0	+500	197.70	+260.0	+500	199.02	+260.0	+500	199.49
+240.0	+464	190.46	+240.0	+464	191.68	+240.0	+464	192.12
+220.0	+428	183.17	+220.0	+428	184.30	+220.0	+428	184.70
+200.0	+392	175.84	+200.0	+392	176.87	+200.0	+392	177.23
+180.0	+356	168.47	+180.0	+356	169.34	+180.0	+356	169.72
+160.0	+320	161.04	+160.0	+320	161.87	+160.0	+320	162.16
+140.0	+284	153.57	+140.0	+284	154.30	+140.0	+284	154.55
+120.0	+248	146.06	+120.0	+248	146.68	+120.0	+248	146.90
+100.0	+212	138.50	+100.0	+212	139.02	+100.0	+212	139.20
+80.0	+176	130.89	+80.0	+176	131.31	+80.0	+176	131.45
+60.0	+140	123.24	+60.0	+140	123.55	+60.0	+140	123.66
+40.0	+104	115.54	+40.0	+104	115.75	+40.0	+104	115.82
+20.0	+68	107.79	+20.0	+68	107.90	+20.0	+68	107.93
0.0	+32	100.00	0.0	+32	100.00	0.0	+32	100.00
-17.8	0	93.01	-17.8	0	92.94	-19.5	-4	92.67
-28.9	-20	88.61	-28.9	-20	88.51	-40.0	-40	83.99
-40.0	-40	84.21	-40.0	-40	84.06	-60.0	-76	75.90
-51.1	-60	79.81	-51.1	-60	79.59	-62.2	-80	75.01
-62.2	-80	75.39	-62.2	-80	75.11	-67.8	-90	72.74
-73.3	-100	70.95	-73.3	-100	70.60	-73.3	-100	70.48

*For 200 ohm platinum elements multiply above resistance values by 2. For 500 ohm platinum elements multiply above resistance values by 5.

HOW TO USE THE PERCENTAGE OF SPAN TABLES

This table has been provided as a quick reference in determining the dial setting of the digital set points in relationship to the corresponding temperature of the controller.

In this case, the digital set point is divided into incremental settings of one one-thousandths ($1/1000$) and is spread over a 300° span (-100°F to $+200^{\circ}\text{F}$).

Thus, to find the digital setting that is equivalent to $+80^{\circ}\text{F}$, you look down the degree F column to +80 and across to the zero vertical column. This indicates that a digital setting of .556 will give a controller set point temperature of 80°F .

Similarly, to find an equivalent digital setting for 85°F , you look down the degree F column to 80 and go across to unit column 5. (This represents 85°F .) The figure 573 is the corresponding digital setting for an 85°F temperature. The fourth digit may be used to round the third digit in the dial setting. For any fourth digit of 5 or more, add one number to the third digit of the dial setting; for any fourth digit of less than five, no change is made in the third digit dial setting.

For example, if the digital number is .5768 (86°F), you would round the dial setting to 577. If the digital setting were .5664 (83°F) you would set the dial for 566.

COPPER VS. COPPER-NICKEL

(COPPER-CONSTANT)

TEMPERATURE IN DEGREES F.		PERCENT OF ABSOLUTE MILLIVOLT SPAN										RANGE -100 TO +200 F	
		TYPE Y											
DEG F	0	2	3	4	5	6	7	8	9	10	DEG F		
100-	0.0000									0.0000	100-		
90-	0.0268	0.0242	0.0215	0.0187	0.0161	0.0134	0.0106	0.0080	0.0053	0.0027	0.0000	90-	
80-	0.0543	0.0516	0.0488	0.0461	0.0433	0.0406	0.0379	0.0351	0.0323	0.0296	0.0268	80-	
70-	0.0823	0.0794	0.0766	0.0737	0.0710	0.0682	0.0654	0.0626	0.0598	0.0571	0.0543	70-	
60-	0.1107	0.1078	0.1049	0.1021	0.0992	0.0963	0.0934	0.0907	0.0879	0.0850	0.0823	60-	
50-	0.1395	0.1366	0.1337	0.1308	0.1279	0.1250	0.1221	0.1192	0.1163	0.1134	0.1107	50-	
40-	0.1609	0.1580	0.1551	0.1522	0.1493	0.1464	0.1435	0.1406	0.1377	0.1348	0.1319	40-	
30-	0.1986	0.1957	0.1927	0.1898	0.1868	0.1838	0.1808	0.1779	0.1749	0.1719	0.1689	30-	
20-	0.2290	0.2260	0.2229	0.2199	0.2169	0.2139	0.2109	0.2078	0.2047	0.2017	0.1986	20-	
10-	0.2599	0.2568	0.2536	0.2506	0.2475	0.2445	0.2414	0.2382	0.2351	0.2321	0.2290	10-	
	0.2912	0.2880	0.2848	0.2817	0.2785	0.2753	0.2722	0.2690	0.2658	0.2626	0.2594		
10	0.2912	0.2942	0.2974	0.3005	0.3037	0.3069	0.3101	0.3133	0.3164	0.3196	0.3228	10	
20	0.3228	0.3260	0.3292	0.3324	0.3356	0.3388	0.3420	0.3452	0.3485	0.3518	0.3550	20	
30	0.3550	0.3582	0.3614	0.3646	0.3678	0.3710	0.3742	0.3774	0.3810	0.3843	0.3875	30	
40	0.3875	0.3907	0.3939	0.3971	0.4003	0.4035	0.4067	0.4099	0.4131	0.4162	0.4195	40	
50	0.4205	0.4237	0.4271	0.4305	0.4339	0.4372	0.4404	0.4437	0.4471	0.4505	0.4538	50	
60	0.4539	0.4572	0.4605	0.4639	0.4673	0.4706	0.4740	0.4773	0.4807	0.4841	0.4874	60	
70	0.4874	0.4907	0.4939	0.4972	0.5005	0.5038	0.5071	0.5104	0.5137	0.5171	0.5204	70	
80	0.5215	0.5248	0.5280	0.5313	0.5346	0.5379	0.5411	0.5444	0.5477	0.5510	0.5543	80	
90	0.5560	0.5594	0.5626	0.5659	0.5691	0.5723	0.5756	0.5788	0.5821	0.5853	0.5886	90	
100	0.5900	0.5943	0.5978	0.6014	0.6049	0.6084	0.6119	0.6154	0.6189	0.6224	0.6259	100	
110	0.6259	0.6296	0.6331	0.6366	0.6401	0.6436	0.6471	0.6506	0.6541	0.6576	0.6611	110	
120	0.6617	0.6652	0.6689	0.6724	0.6760	0.6795	0.6831	0.6866	0.6901	0.6937	0.6972	120	
130	0.6977	0.7012	0.7049	0.7086	0.7122	0.7159	0.7196	0.7231	0.7267	0.7304	0.7341	130	
140	0.7341	0.7377	0.7414	0.7451	0.7487	0.7523	0.7559	0.7595	0.7631	0.7667	0.7703	140	
150	0.7709	0.7747	0.7784	0.7820	0.7856	0.7892	0.7928	0.7964	0.8000	0.8036	0.8071	150	
160	0.8081	0.8120	0.8156	0.8194	0.8231	0.8269	0.8307	0.8344	0.8382	0.8420	0.8459	160	
170	0.8459	0.8495	0.8533	0.8572	0.8610	0.8648	0.8686	0.8724	0.8761	0.8800	0.8837	170	
180	0.8837	0.8875	0.8914	0.8952	0.8990	0.9028	0.9066	0.9104	0.9142	0.9180	0.9218	180	
190	0.9222	0.9260	0.9299	0.9337	0.9375	0.9413	0.9451	0.9489	0.9527	0.9565	0.9603	190	
200	0.9609	0.9646	0.9684	0.9722	0.9760	0.9797	0.9835	0.9872	0.9910	0.9947	0.9985	200	
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F	

PROTECTIVE OR SAFETY DEVICES

The following are the protective or safety devices used in the refrigeration and electrical circuits (besides the branch circuit protection). Refer to electrical and refrigeration schematics.

RELIEF VALVES:

One is located in the high pressure piping of the R-13 system; one is located in the high pressure piping of the R-502 system; and one is located in the low pressure piping of the R-13 system, to protect the systems against excessive pressure. The valves in the high pressure piping are factory-designed to relieve at 400 P.S.I. and the valve in the low pressure piping is designed to relieve at 150 P.S.I.

PRESSURE SWITCHES:

One in each refrigeration system - R-13 primary cooling system and R-502 secondary cooling system. The R-13 switch is piped to sense the pressure of the discharge side of the refrigeration compressor, set to interrupt the control circuit of the compressor at abnormal pressure (cut in at 250#, cut out at 235#). The R-502 switch is piped to sense the pressure of the suction side of the R-13 compressor to momentarily delay starting (cut in at 25#, cut out at 35#). The switches are manually reset. (Factory set and adjustable.)

PROTECTIVE OR SAFETY DEVICES

HI-HEAT LINK: (Electrical Schematic)

Is wired in series with the heater to open the circuit to protect the chamber from exceeding designed temperature limits. This control will open when the chamber temperature reaches approximately 400°F. (Not resettable; replace.)

INHERENT OVERLOAD PROTECTION:

Located in each refrigeration compressor motor. These are factory designed to open the motor circuit within safe limits. (Non-adjustable; automatic reset.)

INTERLOCK:

The circuit motor is interlocked with the heat control circuit to protect the heaters.

A GUARD is provided for the circulator fan.

REFRIGERANTS used are non-toxic.

ALL ELECTRICAL CIRCUITS are separately fused.

ALL MACHINERY is enclosed.

OPERATING INSTRUCTIONS

These operating instructions will tell the operator what must be done to place the chamber in operation. A thorough study of the electrical schematic and operating instructions of each control component should be made to become proficient in operating this chamber.

ONE SET POINT TEMPERATURE OPERATION: (Manual)

One set point operation is described as that operation in which one temperature is maintained for an extended period. This may be any condition in the range of the chamber. The following steps can be followed to put the chamber in operation:

1. Place the HUMIDITY/TEMP switch in the TEMP position.
2. Prepare the Honeywell 452 programmer-recorder as follows:
 - A. Turn the power switch, located inside the programmer-recorder door, to the ON position. The cam switch must be in the OFF position.
 - B. Install new circular chart.
 - C. Rotate chart and chart hub by turning hub until correct time line on chart is opposite time index.
 - D. Ink the recorder dry bulb pen.
3. Place the PROG/MAN switch in the MAN position.
4. Place the S.P./TEMP switch in the S.P. position.
5. Place the W.B./D.B. switch in the D.B. position.
6. Turn the DRY BULB SET POINT control knob until the desired set point is reached. The needle on the controller dial is the set point indicator.

OPERATING INSTRUCTIONSONE SET POINT TEMPERATURE OPERATION: (Continued)

7. To simulate temperatures above +120°F, place the HEAT/COOL switch in the HEAT position.
8. To simulate temperature below +120°F, place the HEAT/COOL switch in the COOL position.
9. Place the S.P./TEMP switch in the TEMP position. The meter will now indicate chamber temperature.

OPERATING INSTRUCTIONSONE SET POINT HUMIDITY OPERATION: (Manual)

1. Place the HUMIDITY/TEMP switch in the HUMIDITY position.
2. Prepare the Honeywell 452 programmer-recorder as follows:
 - A. Turn the power switch, located inside the programmer-recorder door, to the 'ON' position. The cam switch must be in the OFF position.
 - B. Install new circular chart.
 - C. Rotate chart and chart hub by turning hub until correct time line on chart is opposite time index.
 - D. Ink the recorder dry bulb and wet bulb pens.
3. Place the PROG/MAN switch in the MAN position.
4. Place the S.P./TEMP switch in the S.P. position.
5. Place the W.B./D.B. switch in the D.B. position.
6. Turn the DRY BULB SET POINT CONTROL knob until the desired set point is reached. The needle on the controller dial is the set point indicator.
7. Place the W.B./D.B. switch in the W.B. position.
8. Turn the WET BULB SET POINT control knob until the desired set point is reached. The needle on the controller dial is the set point indicator.

NOTE: Refer to the temperature/humidity chart. The wet bulb depression values are shown in 1 degree increments across the top of the table; dry bulb temperature values are in the left hand column; and the relative humidity values in the major portion of the table. For example: 80% RH for +125°F dry bulb temperature is a wet bulb set point of +118°F.

9. Place the S.P./TEMP switch in the TEMP position. The meter will now indicate chamber temperature.
10. Place the HEAT/COOL switch in the COOL position.

OPERATING INSTRUCTIONSPROGRAMMED HUMIDITY OPERATION:

Programmed operation is described as that operation in which the environment follows a succession of predetermined conditions as outlined in the programming cam. These conditions may cover the entire designed range of the chamber in one programmed operation.

Humidity programming is accomplished by programming the dry bulb set point and the wet bulb set point from the Honeywell 452 programmer recorder. Placing the controller's PROGRAM/MANUAL set point selector switch in the PROGRAM position allows the controller to accept set point signals from the Honeywell 452 programming potentiometers. The program profile is cut on circular cams (Part No. P4CAM1-1) which are graduated from 0 to 100 percent.

The desired program temperature to be run is found on a temperature vs. percentage of span table and converted into a percentage value. The cam is then cut at this percentage value.

Dry bulb and wet bulb cams are then synchronized and deliver their set point signals to the controller for required humidity conditions. The recording portion of the Honeywell 452 will record the dry bulb temperature and the difference between dry and wet bulb temperatures.

The following steps will help the operator place the chamber in programmed operation:

1. Place the HUMIDITY/TEMP switch in the HUMIDITY position.
2. Prepare the Honeywell 452 programmer recorder as follows:
 - A. Turn the power switch, located inside the programmer-recorder door, to the ON position. The cam switch must be in the OFF position.

OPERATING INSTRUCTIONSPROGRAMMED HUMIDITY OPERATION: (Continued)

2. (Continued)

- B. Install new circular chart.
- C. Rotate chart and chart hub by turning hub until correct time line on chart is opposite time index.
- D. Ink the recorder dry bulb and wet bulb pens.
- E. Place the program cams on the cam hubs and place the cam follower arms on the cam disc.

3. Place the PROG/MAN switch in the PROG position.

4. Place the S.P./TEMP switch in the S.P. position.

5. Determine the desired relative humidity.

NOTE: Refer to the temperature/humidity chart. The wet bulb depression values are shown in one degree increments across the top of the table; dry bulb temperature values in the left hand column; relative humidity values in the major portion of the table. For example: 80% RH for +125°F dry bulb temperature is a wet bulb set point of +118°F.

6. Place the W.B./D.B. switch in the W.B. position.

7. Position the wet bulb cam follower arm until the needle on the controller dial indicates the wet bulb temperature value determined in the preceding Step 5.

8. Place the W.B./D.B. switch in the D.B. position.

9. Position the dry bulb follower arm until the desired dry bulb temperature is indicated by the needle on the controller dial.

10. Place the S.P./TEMP switch in the TEMP position. The meter will now indicate chamber temperature.

11. Place the HEAT/COOL switch in the COOL position.

12. After the chamber has stabilized at the start point temperature of the cam (as noted by the recording pen), turn the programmer-recorder cam switch ON.

OPERATING INSTRUCTIONSPROGRAMMED TEMPERATURE OPERATION:

This chamber may also be programmed for straight temperature operation by placing the HUMIDITY/TEMP switch in the TEMP POSITION.

Perform the procedures for programmed humidity operation, except utilize the TEMP position. The controller will still provide a wet bulb output but the humidity system will not be operative as may be seen when viewing the electrical schematic.



DRY BULB TEMP. C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	
0	82	64	47	31	14																																									
1	83	66	50	34	18	3																																								
2	84	68	52	37	22	8																																								
3	84	69	54	40	25	12																																								
4	85	70	56	42	29	16	3																																							
5	86	72	58	45	32	19	7																																							
6	86	73	60	47	35	23	11																																							
7	87	75	61	49	37	26	14	3																																						
8	87	75	62	51	40	29	18	7																																						
9	88	76	64	53	42	31	21	11																																						
10	88	77	66	56	46	36	26	17	8																																					
11	88	77	68	57	48	38	29	20	11	3																																				
12	89	78	68	58	49	40	31	23	14	6																																				
13	89	79	69	59	49	40	31	23	14	6																																				
14	90	79	70	60	51	42	33	25	17	9	2																																			
15	90	80	71	61	53	44	35	27	20	12	5																																			
16	90	81	71	62	54	46	37	30	22	15	8	1																																		
17	90	81	72	63	55	47	39	32	24	17	10	4																																		

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FREON 13 SYSTEMCHARGING PROCEDURE

WHEN TO ADD: Refrigerant will need to be added when the standby pressure of the system falls approximately 10 P.S.I. below the level recorded on the equipment serial tag (located on the electrical compartment door).

MATERIAL REQUIRED: 1 set of manifold refrigeration gauges, three charging hoses, one tank of Freon 13.

Note: Freon 13 at ambient temperature is at a pressure exceeding 450 P.S.I. Extreme care should be taken in handling this gas.

CHARGING PROCEDURE:

1. Connect the charging hoses to the refrigeration gauges.
2. Connect the center charging hose to the Freon 13 tank outlet valve. (Be sure the valve is OFF.)
3. Turn the compressor discharge and suction service valves all the way counter-clockwise; backseating the valves.
4. Connect the suction gauge hose to the compressor suction service valve. Connect the discharge gauge hose to the compressor discharge service valve.
5. Open the hand valves on the gauge manifold and bleed (purge) a small amount of gas through the charging hose.
6. After the hoses are purged, close the Freon 13 tank outlet valve and tighten the hose fittings on the compressor service valves.
7. Turn the compressor suction and discharge service valves clockwise (half turn only). Any charge in the system will be read on the gauges. This charge is referred to as the standby pressure. To read the proper pressure, the chamber and cascade compartment must be at ambient temperature.
8. To add gas, slowly open the outlet valve on the Freon 13 tank, allowing the higher pressure gas in the tank to flow into the refrigeration system; when the gauge reads the pressure indicated on the equipment serial tag (located on the electrical compartment door) close the outlet valve of the Freon 13 tank.
9. Allow the unit to stand for 15 minutes and recheck the standby. It will probably be necessary to add more gas. Again, open the outlet valve on the Freon 13 tank and raise the standby to the proper level. Close the valve.

10. Allow the chamber to stand approximately 15 minutes and recheck the standby. This procedure may be followed until the proper standby is reached.
11. After the standby is reached, turn both hand valves on the manifold all the way clockwise. (Frontseat.)
12. With the hand valves in this position, the operating pressures of the system may be read when the equipment is running.
13. If it is desired that the gauges be removed, backseat both compressor service valves (turned all the way counter-clockwise) and remove the charging hoses.

FREON 502 SYSTEMCHARGING PROCEDURE

WHEN TO ADD: Refrigerant will need to be added when bubbles appear in the sightglass; during pulldown after 2 minutes of operation.

MATERIALS REQUIRED: One set of manifold refrigeration gauges, three charging hoses, one tank of Freon 502.

PROCEDURE:

1. Connect the three charging hoses to refrigeration gauge manifold.
2. Connect the center charging hose to the Freon 502 tank. (Outlet valve of tank must be OFF.)
3. Turn the suction and discharge service valves on the compressor all the way out (backseat).
4. Connect the hose from the suction gauge to the compressor suction service valve. Leave the fitting loose.
5. Connect the hose from the discharge gauge to the compressor discharge service valve. Leave the fitting loose.
6. Open both hand valves on the refrigeration gauge manifold.
7. Slowly open the outlet valve on the Freon 502 tank and purge the charging hoses.
8. Tighten the hose connections on the compressor suction and discharge service valves.
9. Turn the discharge hand valve on the refrigeration gauge manifold all the way clockwise (frontseat). The suction hand valve should remain open.
10. Turn the compressor section and discharge service valves clockwise (half turn only). Any charge in the system will be read on the gauges.
11. Start the R-502 compressor and watch for bubbles in the sightglass. This must be checked on the pulldown after a minimum of two minutes of running.
12. Open the outlet valve on the Freon 502 tank and allow the refrigerant to flow until there are no bubbles in the sightglass.

13. Turn OFF the outlet valve on the Freon 502 tank.

14. Continue to watch the sightglass for bubbles during normal pulldown operation. If bubbles appear, more Freon 502 may have to be added.

NOTE: If bubbles appear during the bypass operation, this does not indicate a low charge.

15. To use the gauges during compressor operation, both hand valves should be turned all the way in (frontseated).

16. To remove the gauges, turn the compressor section and discharge service valves all the way counter-clockwise (backseat) and remove the charging hoses.

MAINTENANCE
TROUBLESHOOTING GUIDE

Symptoms	Cause	Remedy
A. Compressor does not run.	1. Main power disengaged.	1. Close main power disconnect or equipment disconnect switch.
	2. Fuse blown.	2. Replace fuse.
	3. Compressor seized.	3. If the compressor has caused the inherent overloads to trip, allow time for the compressor to cool and the inherent overloads to reset. Restart the compressor. If the compressor will not start, notify the factory for further assistance.
	4. Compressor control circuit open.	4. Check for open control circuit.
B. Compressor will not start; hums intermittently. (cycling on overload.)	1. Improperly wired.	1. Check wiring against diagram.
	2. Low line voltage.	2. Check main line voltage; determine location of voltage drop.
	3. Open starting capacitor.	3. Replace starting capacitor.
	4. Open circuits in starting winding	4. Make a continuity check of the starting winding.
	5. Stator winding grounded.	5. Make a continuity check from the stator winding to ground.
	6. High discharge pressure.	6. Check for refrigeration overcharge or non-condensables.

Symptoms	Cause	Remedy
C. Compressor starts, motor will not get off starting winding.	1. Low line voltage.	1. Bring up voltage.
	2. Improperly wired.	2. Check wiring against diagram.
	3. Defective start-run relay.	3. Check operation manually; replace relay if defective.
	4. Running capacitor.	4. Check by disconnecting running capacitor.
	5. Starting and running windings shorted.	5. Check resistances. replace stator if defective.
	6. Starting and running windings shorted.	6. Check capacitance; replace if low.
	7. High discharge pressure.	7. Check for refrigerant overcharge or non-condensables.
D. Start-run relay burnout.	1. Low line voltage.	1. Increase voltage to not less than 10% under compressor motor rating.
	2. Excessive line voltage.	2. Reduce voltage to maximum of 10% over motor rating.
	3. Incorrect running capacitor.	3. Replace running capacitor with correct mfd. capacitance.
	4. Short cycling.	4. Reduce number starts per hour. (See Sect.B)
	5. Incorrect mounting.	5. Mount relay in correct position.
	6. Incorrect relay.	6. Use relay properly selected for motor characteristics.
	7. Relay vibrating.	7. Mount relay in rigid location.

Symptoms	Cause	Remedy
E. Insufficient cooling effect.	1. Refrigerant shortage.	1. Repair leak and recharge.
	2. Frosted coil.	2. Defrost and dry coil.
	3. Air-cooled condenser obstructed.	3. Clear obstruction.
	4. Compressor inefficient.	4. Check for defective valves.
	5. Capillary tube obstructed.	5. Remove obstruction.
	6. Heat generating load is too great.	6. Consult factory for assistance.
F. R-13 head pressure too high.	1. Refrigerant over-charge.	1. Relieve some gas from system.
	2. Non-condensables in system.	2. Evacuate to re-charge.
	3. R-502 system short of gas.	3. Repair leak and re-charge.
	4. Bypass solenoid not opening.	4. Replace.
	5. R-13 pressure switch PS11 defective.	5. Replace.
G. R-13 head pressure too low.	1. Refrigerant shortage.	1. Repair leak and re-charge.
	2. Compressor inefficient.	2. Replace.
	3. Bypass solenoid not closing.	3. Replace.

Symptoms	Cause	Remedy
H. R-502 head pressure too high.	1. Condensing air too warm.	1. Supply cooling air.
	2. Restricted air-cooled condenser.	2. Clean condenser.
	3. Non-condensables in system.	3. Evacuate and re-charge.
I. R-502 head pressure too low.	1. Condensing air too cold.	1. Heat air.
J. Noisy unit.	1. Tubing rattle.	1. Bend tubes away from contact.
	2. Mountings loose.	2. Tighten.
	3. R-13 pressure switch PS11 defective.	3. Replace.
	4. Refrigerant flooding back.	4. Consult factory for assistance.
K. Compressor loses oil.	1. Shortage of re-frigerant.	1. Repair leak and recharge.
	2. Short cycling.	2. Refer to Section B.
L. Chamber will not control at ambient.	1. Instrument mis-adjusted.	1. Recalibrate
	2. Defective thermo-couple.	2. Replace.
	3. Low voltage.	3. Consult factory for assistance.

DEHUMIDIFICATION

The dehumidification process is achieved by utilizing the dew point factor of basic psychrometry. This method of reducing and controlling the moisture content of the conditioned air within the test space allows the relative humidity to vary in a natural and governed process without introducing unnecessary air, heating, or cooling which would upset vapor pressures and temperatures.

Refrigerant flows through the dehumidify expansion valve and the dehumidify coil. The temperature of the dehumidify coil is maintained by the dehumidify expansion valve located in the dehumidify refrigeration circuit. The moisture in the chamber condenses on the surface of the dehumidify coil and the moisture is collected in a pan. The water is then removed from the chamber through a drain tube.

HUMIDIFICATION

GENERAL DESCRIPTION:

The humidity vapor generator is located outside of the chamber work space. It consists of an independent and automatic heating system combined with the chamber air circulation. All component parts are made of copper, brass, or stainless steel to prevent corrosion of the system. The entire assembly is easily removed to allow repair or cleaning of the unit on a bench.

The vapor generator assembly consists of a vapor tank, a water level control, and inonel sheath heater, and a safety heat limit for over temperature-low water protection. When power is applied to the heaters the temperature of the water in the vapor generator rises until it reaches the boiling point. The steam vapor that is generated migrates through a tube to the interior of the chamber. The vapor enters the chamber in the plenum area where it is mixed with the chamber air.

Level control of water in the wet bulb reservoir is maintained by an automatic feeder. The reservoir size is held to a minimum most suitable to the instrument bulb size. The shape of the reservoir insures against any damage by test chamber temperatures. The reservoir is heliarc welded, stainless steel.

THEORY:

The system operates on the basis of the immersion heater increasing the water vapor pressure in the vapor generator above that of the conditioning plenum, causing the vapor to migrate to the conditioning plenum, where it is mixed with the conditioned air and then delivered to the work space. This principle maintains proper control of wet temperature, with minimum influence on the dry bulb temperature.

HUMIDIFICATION

THEORY: (Continued)

When power is applied to the heaters, the temperature of the water in the vapor generator rises until it reaches the boiling point. The steam vapor that is generated migrates through a tube to the interior of the chamber. The vapor enters the chamber in the plenum area where it mixes with the chamber air. This chamber air passes over the humidity sensor, which in turn, supplies a signal to the wet bulb controller. The wet bulb controller compares this signal to the set point signal of the controller and supplies the proper command to the vapor generator. The heaters in the vapor generator either remain ON or are turned OFF, depending on the signal from the wet bulb controller, and the cycle repeats.

If there is no water in the vapor generator when power is applied to the heaters, the temperature of the vapor generator will begin to rise toward the skin temperature of the inconel sheath heater. To prevent this, a direct contact thermostat has been mounted on the side of the vapor generator. When the temperature of the vapor generator reaches the setting of the thermostat (225°F.), the heat limit opens and removes power from the heater. The thermostat is manual reset type and cannot apply power to the heater until the thermostat is manually reset. As an added precaution, a heater with a low watt density has been used to assure the heater will not burn out if the heater is energized when there is no water in the vapor generator and the heat limit fails.

The water level in the vapor generator is maintained by the water boy float assembly attached to the side of the vapor generator. The float level is fixed, and the water level of the vapor generator is determined by the relative position of the fixed float assembly to the vapor generator. A pressure equalizer line has been installed between the float assembly and the vapor generator. This assures that the water levels in the two devices will be at the same level since there will be no pressure difference between them.

The wick well water level is controlled by a float assembly located on the side of the chamber. The wick well water level is maintained by adjustment of the ball float in the float assembly. This should be adjusted to maintain the water level about 1/4" from the top of the well. If the float should stick open, the float assembly is equipped with an over-flow tube.

To drain the wick well and the float assembly, close the water supply shutoff valve and open the drain valve. The water will drain from the wick well through a tube welded to the float assembly. This allows for fast fill and drain. To fill the system reverse the procedure.

HUMIDIFICATION

MAINTENANCE:

- Weekly - Drain the vapor generator and the wick well until all traces of sediment disappear from the drain water.
- Quarterly - Remove the vapor generator from the chamber and completely disassemble it. Remove any scaling or sediment present inside the vapor generator and float assembly.

NOTE: For this system to operate properly, with the carefree operation for which it was designed, use only distilled or demineralized water. This prevents scaling and mineral build-up which leads to a deterioration of system performance.

Thermotron also recommends the wet bulb wick be changed periodically to assure optimum system operation. The wick should be made of a light-weight cotton material. These wicks can be purchased directly from most control instrument manufacturers. (Such as Bristol, Part No. A-1433.) These wicks should be kept clean for proper wet bulb instrument operation.

The float assembly is constructed with a small clearance between the float and body of the valve. When working on the float assembly, or removing it for cleaning or repair, never hold the body of the float with any gripping device. Always use two wrenches on the hexagonal fittings provided.

VAPOR GENERATOR REMOVAL:

The vapor generator is supported by two end plates that are bolted to two hanger brackets.

To remove the vapor generator from the cabinet:

1. Turn OFF the supply water to the chamber and remove the 1/4" flare nut at the top of the water boy float assembly.
2. Turn the electrical power to the chamber OFF and remove the wire connections from the heater terminals, which are located inside the terminal box on the end of the vapor generator.
3. Loosen the connection in the vapor outlet tube.
4. Remove the four mounting bolts. The vapor generator is now free and may be removed from the cabinet.

HUMIDIFICATION

(Continued)

OPERATION:

To place the vapor generator in operation:

1. Connect a supply of demineralized or distilled water to the 1/4" coupling provided at the rear of the chamber. If the water supply exceeds 75 P.S.I. a pressure reducing valve must be used.
2. Control the ON time of the heaters to attain the proper humidity level in the chamber.

To place the wick tank in operation:

1. Close the water boy drain valve.
2. Open the water supply shutoff valve.
3. Adjust the water level on the wick tank float assembly to the desired level. (About 1/4" from top of well.)
4. Install a sock or cloth on the wet bulb sensor.

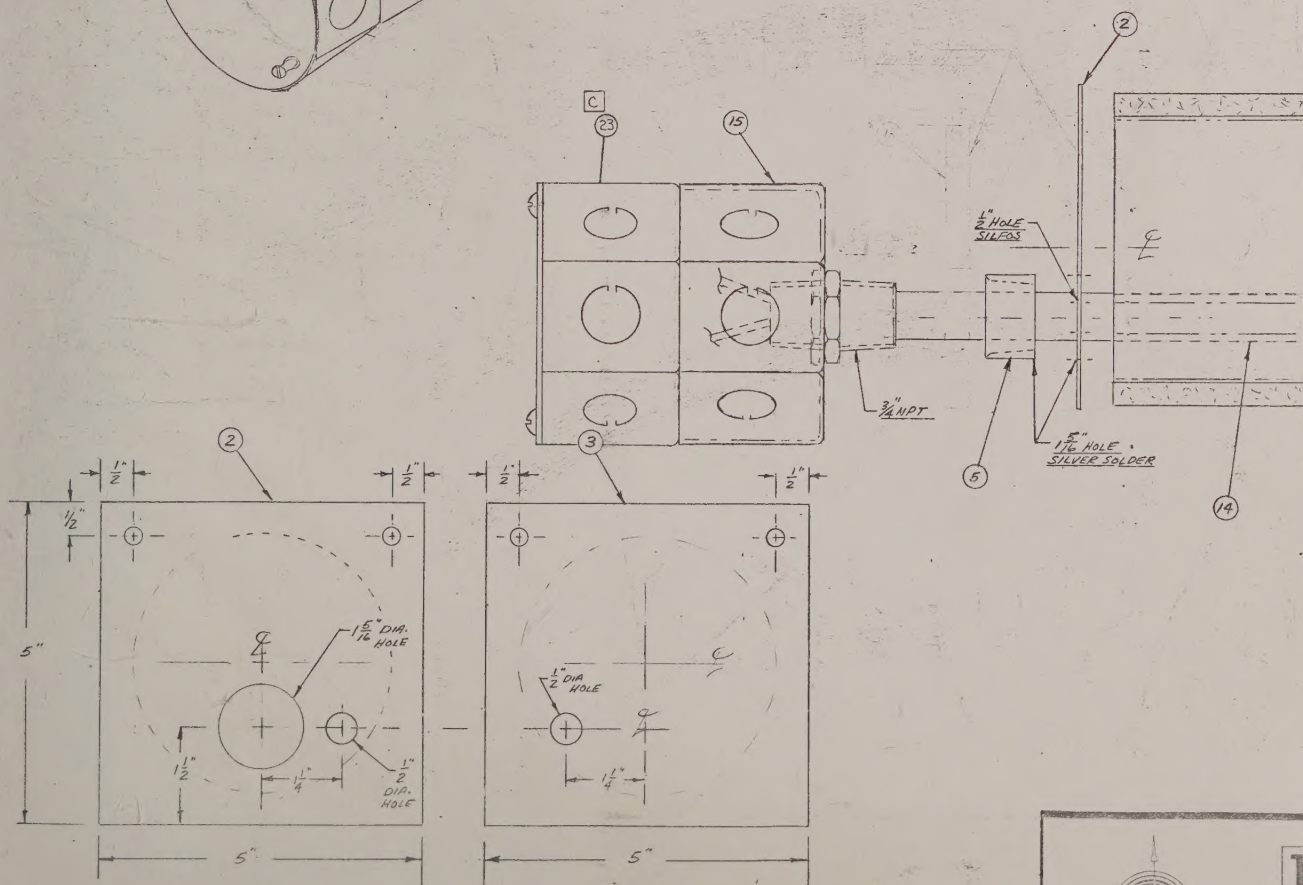
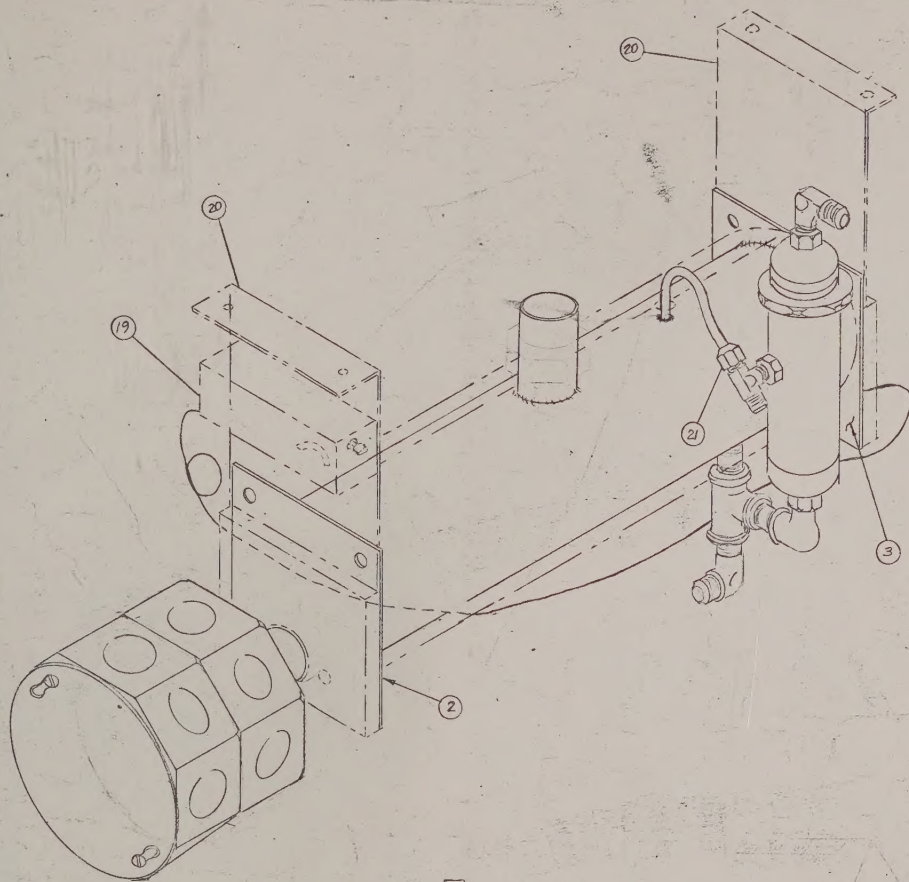
OPERATING INSTRUCTIONS

for

2 or 5 Gallon Recirculating System

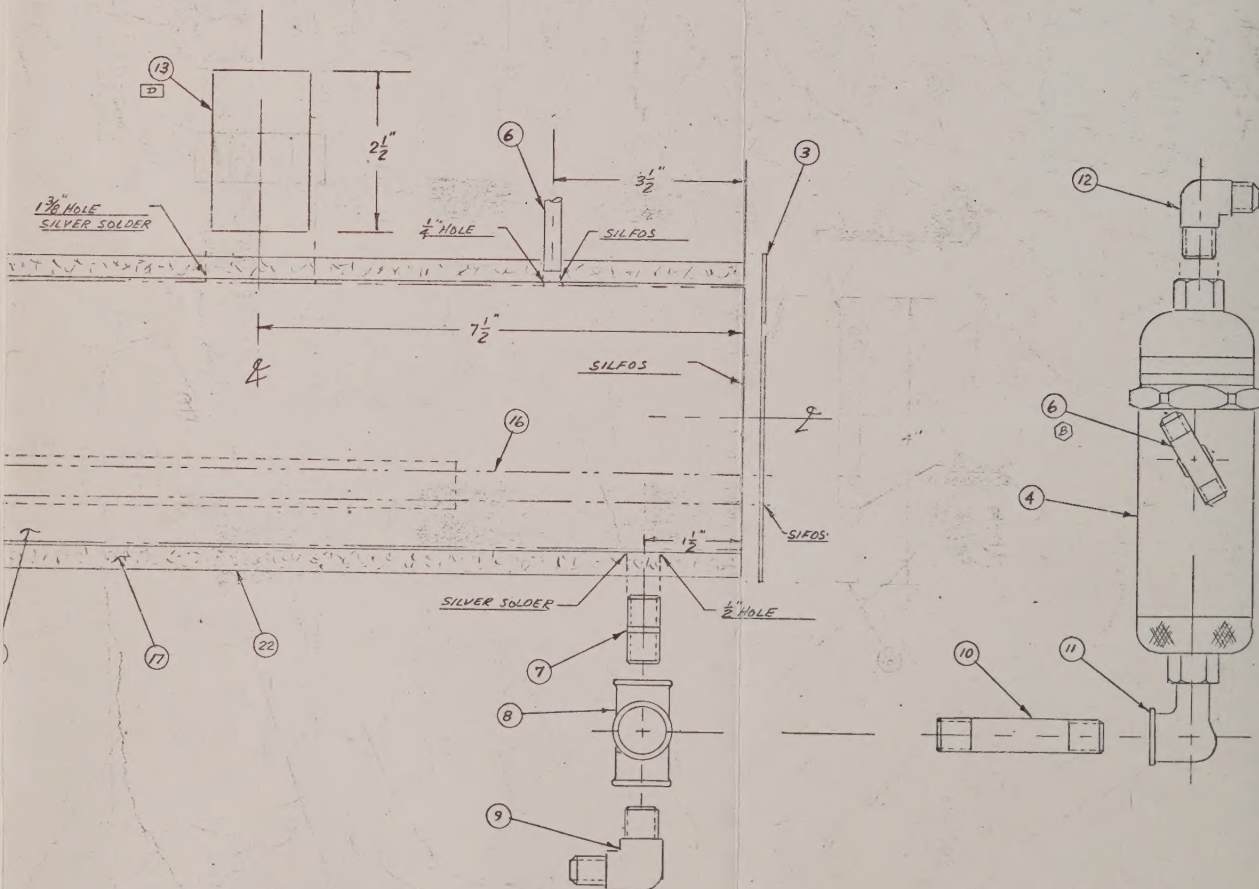
1. Fill the 2 or 5 gallon tank with water (preferably demineralized).
2. Install deionizing filter. There are two (2) washers, one for the top of the filter and one for the bottom. These washers are to be centered to eliminate leaks. Tighten plastic locking collar by hand. (Do not use a wrench.)
3. Open inlet valve to filter and the fill valve for the steam generator.
4. Open the inlet petcock valve on the wick tank located on the right side of the chamber as you face it.
5. Open the valve on the 2 or 5 gallon tank.
6. Turn chamber ON.
7. When filter turns a dark color, close the wick tank drain and steam generator drain.

* When using the chamber for temperature testing only, drain the wick tank on the side of the chamber by opening the petcock valve to the drain and closing the petcock valve to the inlet.



ITEM	UNIT	COMP. PART	PART NO.	DESCRIPTION	SIZE
1	1	PTUB-DWVS	DWV	4 1/2" O.D. COPPER TUBING	15' LG
2	1		STK	COPPER PLATE	5" X 5" X 1/2 GA.
3	1		STK	" "	5" X 5" X 1/2 GA.
4	1	548372	85	WATER-BOY FLOAT ASSY	
5	1	PO.		3/4" FPT BRASS HALF COUPLING	
6	1	547060	A-345	HALF UNION TEE	1/4" X 1/2" NPT X 1/2"
7	1	578816	215PN-4	NIPPLE BRASS 1/2" X 1" LG	1/2" NPT X 1" LG
8	1	575043	1203P-4	TEE BRASS	1/2" NPT
9	1	535289	A-4890	HALF UNION ELBOW	1/2" FLARE X 1/2" NPT
10	1	PO.	215PNL-4-25	NIPPLE BRASS	1/2" NPT X 2 1/2" LG
11	1	550156	1202P-4-9	ST. ELBOW BRASS	1/2" NPT
12	1	535289	A-4890	HALF UNION ELBOW	1/2" FLARE X 1/2" NPT
13	1	544741	W1014B	COPPER COUPLING	1 1/2" CU SWEAT
14	1	PO.	N/A A21	WIDENABLE TAP HEADER	
15	1	PO.	40 1/2	HEATER (WATLOW FIBEROD)	4.5 K.W. 240V
16	1	577658		JUNCTION BOX 4" OCTAGON COVER	
17	1	PO.		COPPER TUBE (BOLD WELL)	1/2" O.D. X 15' LG
18	1	PO.		MICRO-LOK PIPE INSULATION 15' LG	4 1/2" ID. X 15' O.D.
19	1	569221	A19ADN	HEAT LIMIT PENN 100 + 240°F	
20	2	W.O.	1557-1-Y	1557-1-Y CHART BRACKET	
21	1	575892	A-5051	FLARE NUT	1/2" FL
22	LOT	PO.		MICRO-LOK 3" WIDE END LIP TAPE	
23	1	PO.	40E 1/2	4" OCTAGONAL EXTENSION (APPLETON)	1 1/2" DEPTH

NOT
USED



5258-17 (X)

(E) PART NO. 528533 (REV)

ERMOTRON
CORPORATION

AND, MICHIGAN 49423

NO.	CHANGES	DATE	BY	CHK'D	NO.	CHANGES	DATE	BY	CHK'D	TOLERANCE
A	WAS 3.5. 1/4" G.W.L.	12-8-64	M.S.							
B	CHANGED FROM A335	3-14-67	M.S.							
C	ADD 53-111-10	7-19-77	M.S.							
D	REMOVED 17-10	8-27-77	M.S.							
E	ADD 10	8-27-77	M.S.							
F	ADD 10	8-27-77	M.S.							

DESCRIPTION
HUMIDITY VAPOR GENERATOR
ASSEMBLY & PARTS

SCALE 1/4"
MATERIAL AS NOTED

FINISH
DRAWN BY M.S.
CHECKED BY

DATE 10-7-6
DRAWING NO. 1557-
DATE



93455